PROJECT MANUAL

FOR

MATHEWS COMMUNITY CENTER

HARRIS COUNTY - PCT. 03
NEW COMMUNITY CENTER
1728 E Hufsmith Kuykendahl Road
TOMBALL, TX 77375

UPIN 25103MF3MY01
STOA ARCHITECTS PROJ. NO.: 2025-010

ISSUE FOR BID
OCTOBER 12, 2026

STOA ARCHITECTS
6001 Savoy Drive, Suite 100
Houston, Texas 77036
Phone: (713) 995-8784
Fax: (713) 995-8765

DOCUMENT 00 01 03

PROJECT DIRECTORY

CLIENT
Harris County Engineering Department
1001 Preston Street, 7th Floor
Houston, Texas 77002
Phone: (713) 755-5370

ARCHITECT
STOA Architects
6001 Savoy Drive, Suite 100
Houston, Texas 77036
Phone: (713) 995-8784

CIVIL ENGINEER
DALLY + ASSOCIATES, INC
9800 Richmond Ave, Suite 600,
Houston TX 77042
Phone: (713) 337-8881

STRUCTURAL ENGINEER
DALLY + ASSOCIATES, INC
9800 Richmond Ave, Suite 600,
Houston TX 77042
Phone: (713) 337-8881

MEP ENGINEER
INFRASTUCTURE ASSOCIATES
6117 Richmond Avenue, Suite 200
Houston, Texas 77057
Phone: (512) 947-2283

LANDSCAPE
Wong & Associates, Inc.
5207 Spruce St.
Bellaire, Texas 77401
Phone: (713) 777-9198

END OF PROJECT DIRECTORY

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SEALS PAGE



ARCHITECT OF RECORD
STOA ARCHITECTS
6001 SAVOY DRIVE, SUITE 100
HOUSTON, TX 77036

END OF SECTION

SECTION 00 01 07
SEALS PAGE

CIVIL ENGINEER
DALLY + ASSOCIATES, INC.
9800 RICHMOND AVE. SUITE 600
HOUSTON, TX 77042



October 12, 2026

END OF SECTION

SECTION 00 01 07
SEALS PAGE

STRUCTURAL
DALLY + ASSOCIATES, INC
9800 RICHMOND AVE. SUITE 600
HOUSTON, TX 77042



10/12/2026

END OF SECTION

PREPARER'S CERTIFICATION FOR SPECIFICATIONS, SPECIAL SPECIFICATIONS, SPECIAL PROVISIONS, ESTIMATE AND SPECIFICATION DATA

FOR:

The Construction of a New 17, 325 SF Mathews Community Center located at 11603 Hufsmith Kuykendahl Road, Tomball, TX 77375 - Harris County - Precinct 3, UPIN 25103MF3MY01

Special Note:

The following items developed per the published Construction Drawings have been verified and included in the Purchasing Department's Bid Specification Package which can be found on Bonfire.
The items include:

- Pricing/Delivery Information
- Scope of Work
- Special Provision to Standard Specifications
- Special Specifications
- Supplement to General Requirements
- Contract Time



OFFICE OF THE COUNTY ENGINEER

DR. MILTON RAHMAN, P.E., PMP, CFM, ENV SP

11603 Hufsmith Kuykendahl Road, Tomball, TX 77375 - New Building Construction of the Mathews Community Center

SCOPE OF WORK

The Contractor shall furnish all labor, equipment, materials, and incidentals necessary to perform the scope of work identified herein in accordance with the drawings, specifications, and all applicable codes and standards. The scope of work is to provide the following for Harris County - Precinct 3, located at 11603 Hufsmith Kuykendahl Road, Tomball, TX 77375.

1. New construction of the Mathews Community Center and associated site improvements at 11603 Hufsmith Kuykendahl Road, Tomball, Texas 77375. The Work consists of a new, single-story, approximately 17,325 gross-square-foot community center building (Group A-3 Assembly, Type II-B non-combustible construction) and all associated sitework, utilities, paving, landscaping, and phased demolition, complete and ready for occupancy, in strict accordance with the Contract Documents. Bidders shall examine the complete Contract Documents contained in the Project Manual prior to submitting a bid; this summary does not modify or supersede those documents.

2. **SUMMARY OF WORK BY DISCIPLINE**:
   a. **Civil / Sitework —** Phased demolition of existing building, paving and utilities; new parking, drive, and walkway paving; domestic, fire, and sanitary sewer utility extensions; grading and drainage; offsite detention pond A on Broussard Park improvements; fire department access; SWPPP implementation; and installation of one (1) Harris County construction project sign at a location to be determined by Harris County Precinct 3.
   b. **Landscape —** Complete planting palette (trees, shrubs, groundcovers, turf), protection and arborist care for existing trees to remain, and a building-perimeter maintenance edge, coordinated with Civil and Architectural sitework.
   c. **Architectural — Site & Building —** New single-story building complete with interior partitions, ceilings, roofing, lighting protection, exterior envelope (thin-brick veneer, metal wall panels, storefront/glazing), interior finishes, and doors/hardware; new trash, electrical riser, and generator enclosure; protection of existing site items on Mathews and Broussard Park.
   d. **Structural —** New building foundation, and structural steel superstructure and roof framing, and concrete generator pad, per the 2021 IBC (Harris County Amendments) and referenced AISC/ACI/AISI standards.
   e. **Mechanical / HVAC —** New HVAC system, complete ductwork and air devices, and Building Automation System controls, with air balancing and commissioning.
   f. **Electrical —** Complete electrical service, distribution, and branch circuiting; standby/emergency generator system; interior, site, and parking-lot lighting; and fire alarm devices.
   g. **Plumbing —** Domestic water, sanitary waste/vent, and storm drainage systems; water heater; and all fixtures per the Plumbing Fixture Schedule, per IBC Chapter 29 fixture-count requirements.
   h. **Fire Protection —** Design-build automatic wet-pipe fire sprinkler system throughout, installed by a Texas-licensed fire protection contractor per NFPA 13, interlocked with the fire alarm/detection system.
   i. **Technology — Data / AV / Security —** Structured data cabling, audio-visual infrastructure, and electronic security (access control / video surveillance) systems, coordinated with Electrical and Architectural work; refer to Division 27 Matrix per Harris County Design Standard Requirements.
   j. **Existing Park Equipment and Amenities:** Existing Park equipment, amenities, play areas, and walkways designated to remain shall be protected and maintained undisturbed throughout construction. Contractor shall provide portable restroom units for public use as needed during utility service interruptions to the existing park restrooms during installation and connection of new sanitary sewer utility extensions.

GENERAL NOTICE TO CONTRACTORS

In accordance with Texas Local Government Code § 262.025(d), a minimum of 25% of the work to be performed on this project shall be performed by the Bidder.

Special Notice: By law, the original price on firm fixed price contracts may not be increased by more than 25%. The original price may not be decreased by 18% or more without the consent of the contractor. Please monitor additions to your contract - additions in excess of 25% will not be paid under any circumstances.

On public works projects, all contractors shall supply a list of all suppliers and subcontractors with addresses and phone numbers, prior to work commencing.

At the time of the scheduled preconstruction meeting, the successful bidder shall supply to the County with a list of representatives signed by an Officer of the Company who are authorized to sign official documents, i.e., Purchase Orders, Change Orders, Final Estimates, etc.

In determining who is a responsible bidder, Harris County may take into account the past performance of the bidder on Harris Co u n ty projects. Commissioners' Court adopted a written definition and criteria for determining the performance of a contractor which may be considered in determining the responsibility of a bidder.

Harris County is using internet-based software “Construction Management Software (Trimble)” to maintain consistent administrative and technical control for its projects throughout the County. The Contractor is required to use Trimble on this project in accordance with procedures provided by the County. Trimble stores electronic project correspondence and related project documents such as RFI’s (requests for information) and submittals. Trimble provides the ability to view contract bid items/pay estimate status, submittal status, RFI status, and change order history, etc.

At no cost to the Contractor, the County will provide system login account(s) and provide training for Contractor personnel. The Contractor must update Trimble with any new or changed information within 24 hours of that information becoming known to Contractor. The Contractor must have access to a computer with internet access and a scanner to use Trimble.

GENERAL NOTES

1. In the computation of contract time, Saturdays, Sundays, and Holidays are included, however, there is sufficient time on Monday through Friday for the completion of the project. Therefore, any work on Saturdays, Sundays, and Holidays must be approved 48 hours in advance by the County Engineer.

NOTICE TO CONTRACTORS

OF

TEXAS BOARD OF PROFESSIONAL ENGINEERS POLICY ADVISORY REGARDING PROCUREMENT OF ENGINEERING

SERVICES BY GENERAL CONSTRUCTION CONTRACTORS FOR GOVERNMENTAL PUBLIC WORKS PROJECTS

On August 20, 2009, the Texas Board of Professional Engineers adopted a document entitled "Texas Board of Professional Engineers Policy Advisory Regarding Procurement of Engineering Services by a general Contractor for Governmental Public Works Projects". A copy of said Advisory is attached for information should the Contractor decide to obtain any professional engineering services in accomplishing this Project.

TEXAS BOARD OF PROFESSIONAL ENGINEERS

POLICY ADVISORY REGARDING PROCUREMENT OF ENGINEERING SERVICES BY GENERAL CONSTRUCTION CONTRACTORS FOR GOVERNMENTAL PUBLIC WORKS PROJECTS

August 20, 2009

Definitions:

Project Professional Engineer - Engineer(s) or engineering firms retained by a governmental entity to perform engineering services for a specific public works project.

General Construction Contractor - Private entity retained by a governmental entity to construct a public works project designed by the Project Professional Engineer.

Other Professional Engineers - Engineer(s) or engineering firms which may be retained by the General Construction Contractor or his subcontractors or vendors to fulfill engineering requirements of the project during the construction phase.

Background: The Dallas - Ft. Worth International Airport Board (DFWIAB) has requested clarification on the Texas Board of Professional Engineers' (Board) interpretation of the Professional Services Procurement Act (PSPA) requirements contained in the Texas Engineering Practice Act (Act). In the course of complex public works projects, the need often arises for Other Professional Engineers to be engaged to perform tasks unforeseen by the Project Professional Engineers or tasks not authorized to be performed by the Project Professional Engineers since they would involve dictating the General Construction Contractor's means and methods of construction. Examples of such engineering tasks include but are not limited to:

1) Trench safety plans.
2) Traffic control plans.
3) Temporary construction structures (crane foundations, for example).

Applicable Board Rules from the Act:

§137.53 Engineer Standards of Compliance with Professional Services Procurement Act

A licensed engineer shall not submit or request, orally or in writing, a competitive bid to perform professional engineering services for a governmenta1 entity unless specifically authorized by state law and shall report to the board any requests from governmental entities and/or their representatives that request a bid or cost and/or pricing information or any other information from which pricing or cost can be derived prior to selection based on demonstrated competence and qualifications to perform the services.

For the purposes of this section, competitive bidding to perform engineering services includes, but is not limited to, the submission of any monetary cost information in the initial step of selecting qualified engineers. Cost information or other information from which cost can be derived must not be submitted until the second step of negotiating a contract at a fair and reasonable cost.

This section does not prohibit competitive bidding in the private sector.

Source Note. The provisions of this §137. 53 amended to be effective June 4, 2007.

§137.79 Standards for Compliance with Professional Services Procurement Act
When procuring professional engineering services, a governmental entity and/or its representative(s) shall comply with the requirements of Subchapter A, Chapter 2254, Texas Government Code and shall select and award on the basis of demonstrated competence and qualifications to perform the services for a fair and reasonable price and shall not select services or award contracts on the basis of competitive bidding.

Adopted by the Texas Board of Professional Engineers August 20, 2009.

Source Note: The provisions of this §137. 79 amended to be effective December 21, 2008.

Analysis of Board Rules, Texas Administrative Code, Title 22, Part 6, Chapter 137: A reading of Board Rule 137.53 reveals that no language exists specific to the selection of Other Professional Engineers that may be required during the construction phase of the project and that would be selected by a General Construction Contractor. Rule 137.53 is specific, however, in that all professional engineers must not divulge cost information prior to being selected solely on their qualifications. The rule also requires licensed professional engineers to report to the Board any instance where a governmental entity and/or their representative requests cost information prior to the qualification-based selection phase. The board would interpret a General Construction Contractor to be a representative of the governmenta1 entity. Similarly, Board Rule 137.79 requires that governmental entities or their representatives use qualification-based selection processes.

Process: If professional engineering services are required during the course of the project, the public entity or the General Construction Contractor must use qualification-based selection to procure all engineering services regardless of when the services are required. The following language is used by the DFWIAB in their contract documents to communicate this requirement to their contractors and representatives:

> *Ancillary/ Integral Professional Services: In selecting an architect, engineer or land surveyor, etc., to provide professional services, if any, that are required by the specifications, bidder shall not do so on the basis of competitive bids but shall make such selection on the basis of demonstrated competence and qualifications to perform the services in the manner provided by section 2254.004 of the Texas Government Code and so shall certify to the Board (DFWIAB) with its bid.*

The above contract 1anguage covers instances where a General Construction Contractor's means and methods would trigger the requirement for Other Professional Engineering services that were not performed by the Project Professional Engineers. Examples include traffic control plans for contractor-controlled disruptions of normal traffic, or instances where Other Professional Engineering services would be sought to build a temporary crane foundation. The General Construction Contractor would use a qualification-based selection process to

select Other Professional Engineers and would certify in writing to the governmental entity that the QBS process was followed, and no pricing or costing data was used in the process.

Limitations: The QBS process performed by General Construction Contractors described in this policy advisory is intended only for those limited instances where:

1) Engineering decisions or designs performed by the governmenta1 entity's Project Professional Engineer would interfere with the contractor's means and methods of construction or
2) Unforeseen construction issues necessitate the services of Other Professional Engineers in the course of the project.

Adopted by the Texas Board of Professional Engineers August 20, 2009.

SPECIAL NOTICE TO CONTRACTORS

In the hauling of construction materials, excavation equipment or other items required in the completion of this project, the attention of prospective bidders is directed to ordinances and regulations of local, municipal, or county governments which limit the type or the gross weight of motor vehicle or construction equipment operating on public roads and streets, or which restrict the use of such equipment on certain streets.

It will be the responsibility of prospective bidders to investigate any limitations in in routing, size of equipment. or gross vehicle weights which may be subject to regulations by local governmental jurisdictions.

Attention of prospective bidders is also invited to the provisions of City of Houston Ordinance No. 62-888, dated June 20, 1962, which requires the licensing of vehicles which are used in the transportation of earth, sand, shell, travel and similar construction or excavated materials.

Approved by Harris County Commissioners' Court July 23, 1962. Vol. 51.

NOTICE TO CONTRACTORS
ON STORM WATER QUALITY AND
ENVIRONMENTAL ISSUES

In addition to the regulatory requirements stated in the General Conditions, the Contractor shall recognize and comply with the following:

SECTION 1. STORM WATER POLLUTION PREVENTION PLANS

A. COVERAGE

Coverage under the Texas Pollutant Discharge Elimination System (TPDES) General Permit TXR150000 for storm water discharges associated with construction activities is required for a project that disturbs 1 acre or greater (or is a part of a larger common plan of development with the potential to disturb 1 acre or greater). Coverage requires the preparation, implementation, inspection, and maintenance of a Storm Water Pollution Prevention Plan (SWPPP), in accordance with the TPDES General Permit.

B. PROJECT CLASSIFICATION

This project is classified as one of three categories listed below. The Contractor shall be responsible for the storm water quality items, accordingly.

1. "Construction Sites That Do Not Require TPDES General Permit Coverage"

The project disturbs less than 1 acre (and is not part of a common plan of development with the potential to disturb 1 acre or more); therefore, coverage under the TPDES General Permit is not required. However, the Contractor shall implement good housekeeping measures to minimize the potential for pollutants, associated with the construction activities, to enter the storm sewer system. Item 725, "General Source Controls", shall be implemented by the Contractor, as well as any other erosion, sedimentation, and pollution controls shown in the plans and project manual.

Or

2. "Small Construction Sites"

The project disturbs 1 acre or more, but less than 5 acres, (or is part of a common plan of development with the potential to disturb 1 acre or more); therefore, coverage under the TPDES General Permit is required. The Contractor shall implement, inspect, and maintain the Storm Water Pollution Prevention Plan shown in the plans and project manual. Certification of a TCEQ Small Construction Site Notice (CSN) in accordance with Part II.E.2 of the TPDES General Permit is required. **The Contractor, as a primary operator, as defined by TPDES General Permit, shall certify one Construction Site Notice (CSN) and provide this to Harris County at the time that the contract is awarded.** Harris County (owner), as primary operator, **as defined by TPDES General Permit**, shall certify a second Construction Site Notice (CSN) at the time the contract is awarded. After the project is awarded, Harris

County shall provide copies of the two certified Construction Site Notices (CSN) to the Contractor and send copies to the local storm sewer operator for notification purposes. Prior to commencing construction activities, the contractor shall laminate and post the notices on the project site in a location where they are readily available for public viewing. The Contractor shall maintain the posted notices until after completion of the construction activities and final stabilization of the project site as defined by the TPDES General Permit. When the project is completed and stabilization is achieved, as defined by the TPDES General Permit, then the Contractor shall note the date that the Small Construction Site Notice was removed from the project site. A copy of the completed Small Construction Site Notice shall be provided to the Engineer with the SWPPP records. The County shall then notify the local storm sewer operator that storm water associated with construction activities is no longer being discharged from the site.

Or

3. **"Large Construction Sites"**
   The project disturbs 5 acres or greater (or is part of a common plan of development with the potential to disturb 5 acres or more); therefore, coverage under the TPDES General Permit is required. The Contractor shall implement, inspect, and maintain the Storm Water Pollution Prevention Plan shown in the plans and project manual. Certification of a Notice of Intent (NOI) in accordance with Part II.E.3 of the TPDES General Permit is required and shall be completed in accordance with Harris County Specification Item Number 700. The Contractor shall not commence with any earth disturbing activities on the project site until:
   - at least seven (7) days after submittal of the NOI (Harris County & Contractors) via U.S. Postal Service, or if utilizing electronic submittal, prior to commencing construction activities,
   - copies of signed NOI's are submitted to any municipal separate storm sewer system (MS4) receiving discharge, at least seven (7) days prior to commencing construction activities. Contractor shall list in the SWPPP the names and addresses of all MS4 operators receiving a copy.
   - copies of the Certified NOI's are posted in a publicly accessible location (copies shall be laminated or placed in weather resistant display case),
   - and copies (Harris County & Primary Contractors) of construction site notice for large sites (CSN) are posted in a publicly accessible location. After construction activities are complete and final stabilization is achieved (as defined by the TPDES General Permit), the Contractor shall certify one Notice of Termination (NOT) form and provide it to Harris County. Harris County shall certify a second NOT form. Harris County shall submit the two NOTs to the TCEQ and the local storm sewer system operator. After the NOTs have been submitted to the TCEQ, then the Contractor shall remove all temporary SWPPP controls, cease SWPPP inspections, and deliver copies of all SWPPP records to

the Engineer who shall archive them for a minimum of three years. The final payment to the Contractor may be held until all SWPPP records are received by the Engineer.

SECTION 2. STORM WATER QUALITY MANAGEMENT PLANS

A. COVERAGE

If this project meets the definition of "new development" or "significant redevelopment" as defined in the Harris County regulations or City of Houston ordinance on storm water quality and the project is not "grandfathered" or "exempt" as defined by the regulation or ordinance, then a Storm Water Quality Management Plan (SWQMP) is required for the project, as shown in the construction plans.

B. CLASSIFICATION

This project is classified as one of three categories listed below. The Contractor shall be responsible for the storm water quality items, accordingly.

1. "SWQ Permit Within Unincorporated Harris County"

If a Storm Water Quality Management Plan with permanent storm water quality controls is shown in the construction plans and the project is located in unincorporated Harris County, then a Storm Water Quality Management Plan is required prior to the start of construction. Prior to the start of construction, the Engineer shall submit the plans and Written Storm Water Quality Management Plan to the Harris County Permits Group and obtain the necessary signatures acknowledging acceptance of the Storm Water Quality Management Plan. The Contractor shall construct the SWQMP structural controls in accordance with the construction plans and maintain the SWQMP structural controls until completion of the project and until the Engineer can certify that the SWQMP structural controls are constructed in accordance with the plans.

Or

2. "SWQ Permit Within City of Houston"

If a Storm Water Quality Management Plan with permanent storm water quality controls is shown in the construction plans and the project is located in the jurisdiction of the City of Houston, then a Storm Water Quality Management Permit is required prior to the start of construction. Prior to the start of construction, the Engineer shall submit to the City of Houston the construction plans, the City of Houston Storm Water Quality Management Plan Application for Permit, and all other related documents shown on the permit application and obtain the Storm Water Quality Management Permit. Prior to the start of construction, the Contractor shall post a performance bond to the City of Houston for the construction of the storm water quality structural controls. The Contractor shall post a copy of the issued permit on the project site, construct the SWQMP structural controls in accordance with the construction plans, and maintain the SWQMP structural controls until completion of the project and until the

Engineer can certify that the SWQMP structural controls are constructed in accordance with the plans. The Engineer shall submit the Storm Water Quality Permit As-built Certificate to the City of Houston and Harris County shall begin implementation of the SWQMP.

Or

3. **"Grandfathered or Exempt from SWQ Permit"** or **"Storm Water Quality Bank"**

If a Storm Water Quality Management Plan, or permanent storm water quality feature, is not shown in the construction plans, then a Storm Water Quality Management Permit is not required prior to the start of construction because it is grandfathered, exempt, or has provided storm water quality measures through the Storm Water Quality Bank.

SECTION 3. OTHER ENVIRONMENTAL ISSUES

A. BIOLOGICAL ISSUES

In accordance with requirements under the federal Migratory Bird Treaty Act, if in the course of construction, a bird rookery, an identified special migratory bird habitat, or a nesting site is discovered on the project site, then the Contractor shall cease work in the area and immediately notify the Engineer. In accordance with the Federal Endangered Species Act and the Texas Parks and Wildlife Code, if a biological mitigation plan for specially protected flora and fauna species has been provided within the construction plans, then the Contractor shall comply with all requirements noted within the plan.

B. WATERS OF THE UNITED STATES INCLUDING ADJACENT WETLANDS

In accordance with Section 404 and Section 401 of the Clean Water Act and Section 10 of the Rivers and Harbors Act, waters of the United States including adjacent wetlands shall not be impacted by the Contractor unless a Department of the Army Permit has been obtained from the U.S. Army Corps of Engineers for the project.

If Harris County has obtained a Department of the Army Permit for this project, a copy of the permit is provided in the project manual. The Contractor shall comply with all requirements of the Department of the Army Permit. The Contractor shall not impact any waters of the United States and adjacent wetlands greater than the area and volume shown in the permit. If the Contractor impacts waters of the United States including adjacent wetlands on the project site that exceeds the area and volume shown in the permit, then the Contractor shall be responsible for any violations that may be issued by the regulatory agencies. If the Contractor deems it necessary to impact waters of the United States including adjacent wetlands that exceed the permit, then the Contractor must first notify the Engineer, and the Engineer may obtain the necessary regulatory clearances prior to allowing the additional impacts to occur.

During construction of the project, if the Contractor uses off-site areas (not owned by Harris County) for

placement of borrow material, disposal of construction debris, staging of construction materials, usage as a field office, or other types of construction related activities, then the Contractor shall be solely responsible for obtaining all environmental permits for the off-site activity, as well as providing all environmental controls and compensatory mitigation requested by the permitting agency. If a regulatory violation occurs as a result of this off-site activity, then the Contractor shall be solely responsible for this violation.

C. STATE OWNED SUBMERGED LANDS

The Contractor shall not impact submerged lands regulated under the authority of the Texas General Land Office, or other local agency, without an easement agreement. If an easement agreement is necessary for the construction activities, then the easement agreement shall be obtained by Harris County.

D. CULTURAL RESOURCES

In accordance with the National Historic Preservation Act and the Antiquities Code of Texas, the Contractor shall not remove or disturb, or cause or permit to be removed or disturbed, any historical, archeological, architectural, or other cultural artifacts, relics, vestiges, remains, or objects of antiquity from the project site. In the event that such items are discovered on the project during construction activities, the Contractor shall immediately notify the Engineer. The site and the potentially significant material shall be protected by the Contractor from further disturbance until a professional examination of them can be made and/or until clearance to proceed with construction has been provided by the Engineer.

E. HAZARDOUS AND PETROLEUM SUBSTANCES

If during the course of construction, the Contractor discovers hazardous or petroleum substances or wastes on the project site, then the Contractor shall immediately cease work in the area and remove all personnel from the area. The contractor shall temporarily close the area to the public, as well; temporary fencing or caution tape shall be installed around the area. The Contractor shall notify the Engineer immediately. Work in the area shall not be permitted until the Engineer has determined that safety and environmental issues have been properly addressed.

SPECIAL PROVISIONS
TO
GENERAL CONDITIONS
FOR
BUILDING CONSTRUCTION AND RELATED WORK
&
ROADS, BRIDGES AND RELATED WORK

In the event of any conflict between these Special Provisions and the General Conditions, these Special Provisions shall control. All capitalized terms in these Special Provisions refer to the defined terms in the General Conditions.

Section 2.5.3, "Project Communication," *is maintained with the following additional sentence:*

Harris County designates Trimble as its official administrative electronic record-keeping and project management system for this Project. Trimble Construct shall serve as the primary platform for the creation, submission, review, tracking, approval, and retention of all Project-related documents, communications, and records.

All submittals, requests for information (RFIs), notices, correspondence, schedules, meeting minutes, daily reports, change requests, payment applications, and other documentation required under the Contract shall be submitted and maintained within Trimble, unless otherwise directed in writing by the County.

The Contractor is responsible for ensuring that all project personnel, subcontractors, and consultants comply with the County's requirements for use of Trimble Construct and maintain current, accurate, and complete records therein. The Contractor shall bear all costs associated with access, training, and use of the system.

Records maintained in Trimble shall constitute the official Project record for purposes of contract administration, dispute resolution, audits, and project closeout. Failure to properly submit or maintain required documentation in Trimble may result in delayed reviews, withheld payments, or other remedies available to the County under the Contract.

Section 4.3.1, "Time for Completion," *is maintained with the following additional sentences:*

<u>Construction Period:</u>
The Notice to Proceed (NTP) shall establish the official commencement date of the Contract Time. Upon issuance of the NTP, the Contractor shall diligently prosecute the Work and achieve Substantial Completion within the time specified herein.

The total Contract Time for completion of the Work shall not exceed Three hundred ninety (390) calendar days, which corresponds to the overall Project duration, unless a written extension is expressly approved by the County.
No extensions of Contract Time shall be granted without the prior written approval of the Project Manager,

acting on behalf of the County. Any request for an extension of Contract Time must be submitted in writing, with full justification, in accordance with the Contract requirements. Verbal approvals, field directives, or informal communications shall not constitute authorization to extend the Contract Time.

Failure to complete the Work within the approved Contract Time may result in the assessment of damages or other remedies as provided in the Contract.

Section 8.2, "Insurance" *is maintained with the additional supplement titled "Harris County Minimum Insurance Requirements Attachment".*

Section 9.14.1.2, "Hours of Work," *is maintained with the following change:*

The Site may be occupied by the County and users from the public during the Project and if so, Contractor shall sequence work so as to not interfere with normal activities of County and public within the site or outside the work area during the project. Work at the Site shall be performed between 6:00 am and 6:00 pm, any day Monday through Friday of any week except on Holidays and/or during schedule constraints defined in the Contract. Contractor will not permit the performance of Work on a Saturday, Sunday, any County Holiday or during identified schedule constraints without County Authorized Representative's written consent given after prior written notice to County Authorized Representative. Contractor shall request exceptions at least 48 hours in advance.

If Contractor is permitted or directed to do Work outside the contract's regular hours (e.g., daytime work and weekend work) or to vary the period during which the Work is performed each day, Contractor shall give County's Authorized Representative a minimum of 48 hours' written notice so that inspections may be performed.

County is not responsible to the Contractor or Contractor's employees for payment of any overtime compensation or any additional payments pursuant to the Fair Labor Standards Act, 29 U.S.C. § 207(a)(1); the Texas Pay Day Act; the Equal Pay Act; Title VII of the Civil Rights Act of 1964, 42

SPECIAL PROVISIONS TO GENERAL CONDITIONS FOR BUILDING CONSTRUCTION AND RELATED WORK & ROADS, BRIDGES AND RELATED WORK

Note: In the event of any conflict between the Special Provisions and the General Conditions, the Special Provisions shall control U.S.C. § 2000e, et seq.; any provisions of the Texas Labor Code; or the Contract Work Hours and Safety Standards Act, 40 U.S.C. § 3701 et seq. Contractor shall be solely responsible for full compliance with the foregoing state and federal laws.

NOTICE OF SPECIFICATIONS

For the construction of this project, the Contractor shall use the attached Special Provisions, Special Specifications, and Harris County Engineering Department (HCED) Specifications Book – 2023 Harris County Standard Specifications for the Construction of Roads and Bridges, effective date October 10, 2023. The current HCED specifications may be found at the HCED website: https://oce.harriscountytx.gov/Services/Consultants-Resources-and-Specifications/Standards-Specification/Standard-Engineering-Design-Specifications

When applicable, the Contractor shall use the Harris County Flood Control District (HCFCD) 2020 Standard Specifications Book. The current HCFCD specifications may be found at the HCFCD website: https://www.hcfcd.org/Resources/Technical-Manuals/Standard-Specifications-Related-Drawings?folderId=15985&view=gridview&pageSize=10

When applicable, the Contractor shall also use the Texas Department of Transportation (TxDOT) 2014 Standard Specifications Book. The current TxDOT specifications may be found at the TxDOT website: https://www.txdot.gov/business/resources/txdot- specifications.html

When applicable, the Contractor shall also use the City of Houston (COH) Standard Specifications. The current COH specifications may be found at the COH website: https://www.houstonpermittingcenter.org/office-city-engineer/design-and-construction- standards

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23 08 00 Commissioning of HVAC
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SECTION 01 10 10

SUMMARY OF WORK

PART 1 - GENERAL REQUIREMENTS

1.1 DESCRIPTION OF WORK

A. The purpose of this Contract is for the Contractor to furnish all labor, equipment, materials, and incidentals necessary to construct the Mathews Community Center and all related site and utility improvements for Harris County - Precinct 03, all complete, operational and in place in accordance with the drawings and specifications, located at 1728 E Hufsmith Kuykendahl Rd, Tomball, TX 77375.

B. In the event of conflicts within the construction documents not clarified by addendum, the Contractor shall provide the better quality or greater quantity of work.

C. On projects with contract price of more than $25,000.00, the Contractor shall provide a construction schedule. The construction schedule will be a bar-type schedule and shall be of sufficient detail to show construction sequence for different items of work. On projects with a contract price of $5,000,000.00 or more, the Contractor shall submit a critical path method (CPM) type schedule showing the sequence of installation for the various components of the work. The construction schedule shall be updated by the Contractor whenever the schedule is impacted.

D. Schedule of Values:

1. The schedule of values may contain separate pay items for Division 1 requirements on bonding and insurance. All other costs shall be prorated across each line item of work.

2. On projects over $500,000.00 the schedule of values shall be divided into labor and material for each line item of work.

E. Permits:

The Contractor shall obtain and pay for all construction-related permits, utility taps, and hook-ups. No additional compensation will be made for time associated with the permit process.

F. A full time designated field superintendent with a minimum of eight (8) years experience in similar construction types must be present at all times that work is in progress, and must be capable of making decisions on the Contractor's behalf. If the field superintendent is absent for any part of any day that work is being performed, then $150.00 per day (for each such occurrence) will be back charged to the Contractor and deducted from the estimate. Repetitive occurrences could be grounds for notifying the bonding company.

G. The Contractor must submit a list of all subcontractors prior to commencing work. During the course of this project, the Architect must be notified of any changes in subcontractors.

H. On projects that require a field office, the Contractor shall have the office complete in place

and fully furnished and operational within 45 calendar days from the signing of the purchase order. Failure to have a fully furnished and operational field office within the allotted 45 calendar days will result in liquidated damages being assessed against the contract in the amount of fifty dollars ($50.00) per day for each day that the field office is not fully operational. The term fully operational shall include but not be limited to: all required utility connections, required furnishings and climate control.

I. Architect shall review test report for fire alarm and security systems prior to substantial completion.

PART 2 - PROSECUTION OF THE PROJECT

2.1 TASKS

A. Temporary Facilities - In addition to field offices required in Division 1 of these specifications, the following shall be provided:

1. Drinking Water
2. Toilet(s)
3. Project Sign (2)

B. Parking:

1. The Contractor shall be responsible for the parking of his vehicles in a legal manner at no additional expense or inconvenience to Harris County.

C. Storage:

1. General - The Contractor shall be fully responsible for the security and safe keeping of any stored materials.

2. In addition to manufacturer’s recommendations, deliver, store, and handle products using materials, means, and methods that shall prevent mildew and mold growth.

3. The Contractor may use proximate open areas of the site for storage of materials at his own risk. Storage areas must be approved by the Architect.

4. The Contractor may not use any existing part of any existing Harris County building for storage of materials unless approved in writing to do so by the Architect.

5. Remote - The Contractor may use a location "on" or "off" the job site for storage of materials. However, if he intends to submit requests for payment for stored materials, then Harris County, at its discretion, may pay for actual cost of material stored (less stipulated retainage) under the following conditions:

a. The Contractor shall apply for and receive advanced written approval from the Architect.

b. The intended location must be judged suitable and secure by the Architect.

c. The storage shall be in a bonded warehouse, in Harris County's name, fully insured.

d. The Contractor shall pay all costs related to the storage including loading, unloading, transportation, warehouse rent, and insurance.

e. The quantity and quality of material shall be inspected by the Architect, to ascertain compliance with the Contract Documents, paid invoices, and materials list.

D. Hours of Work:

1. The Work shall be phased to maintain continuous operation of the existing Mathews Community Center during construction of the new Community Center Refer to C2.00 and C2.10.

a. Phase 1 – Existing Facility and Park Operations: Maintain the existing Community Center and Park in operation, including required public access, parking, accessible routes, utilities, and emergency access, while establishing construction limits and completing site preparation.

b. Phase 2 – New Community Center: Construct and complete the new Community Center, including building, site improvements, utilities, drainage, parking, and associated work, without disrupting ongoing operations of the existing facility.

c. Phase 3 – Transition: Upon substantial completion, required inspections, approvals, commissioning, and Owner acceptance of the new facility, coordinate the relocation of Community Center operations and equipment to the new facility.

d. Phase 4 – Demolition: Following Owner authorization and successful relocation of operations, close and disconnect the existing Community Center as required and demolish the existing Community Center and other designated existing improvements.

e. Phase 5 – Final Site Work: Complete remaining demolition, grading, drainage, utilities, parking, paving, sidewalks, landscaping, and other site improvements associated with the final project condition.

2. The Contractor shall coordinate all construction, utility interruptions, access modifications, demolition, and site activities to minimize disruption to ongoing community operations. No demolition or permanent interruption to the existing Community Center shall occur until the new facility is ready for occupancy and authorized by the Owner.

3. The Contractor shall limit all construction activity to the following times: 7:00 a.m. to 4:00 p.m., Monday through Friday.

4. If it becomes necessary to work on weekends, holidays, and after the hours noted above, a written request to work shall be submitted for approval to the Manager of

Architectural Construction Section, twenty-four (24) hours prior to performing the work. Access to the site during these hours shall be coordinated through the Chief Inspector.

5. Work shall be performed so as to not interfere with normal activities occurring outside the work area.

6. RAIN DAYS

   a. Building Projects - If inclement weather (as defined in the General Conditions) impacts any portion of the project such that the project completion date is delayed (regardless of whether work is being performed on any other scheduled portion of the project during that time), then that day shall be deemed an Inclement Weather Day or Rain Day.

   b. Roofing Projects - If rain or wet roof surface prevents the performance of the work for seven continuous hours between 7 a.m. and 4 p.m. and/or an inclement weather forecast (reported by the National Weather Service by 8 a.m. the same day that the work in question is scheduled) of 30% or more probability of precipitation, which would impact the work for seven continuous hours between the hours of 7 a.m. and 4 p.m., then that day shall be deemed an Inclement Weather Day or Rain Day.

E. Work Commencement:

The Contractor shall notify the Inspector forty-eight (48) hours prior to starting or restarting work on the project.

F. Cover-up Inspection:

1. The Contractor shall notify the Inspector a minimum of forty-eight (48) hours prior to any cover-up inspection. Any work covered-up prior to inspection and sign off shall be considered non-conforming to contract requirements.

G. Concrete Placement:

For all concrete placement of twenty (20) cubic yards or greater, placement must begin no later than 10:00 a.m. on the day scheduled for the placement. If not begun by 10:00 a.m., Harris County, at its sole discretion, and without time or monetary consequences, may reschedule to ensure proper concrete placement and finishing.

H. Wage Scale Posting:

The Contractor shall post the wage scale at all times at the site of work in a prominent place where it can be easily seen by the workers.

I. Pay Estimate Posting:

The most current processed monthly pay estimate for the project shall be posted at the site of work in a prominent place where it can be easily seen by the subcontractors.

J. Testing of Fire Alarm/Security Systems:

The General Contractor shall hire an independent testing agency certified/licensed by Texas Department of Insurance – State Fire Marshalls Office as designated by the Architect/Design Team to perform testing of the fire alarm and security systems.

PART 3 - CONTRACT ADMINISTRATION

3.1 PROCEDURES

A. Clarifications:

All clarifications required by the Contractor shall be requested in an expeditious manner from the Architect in the written form of a Request for Information (RFI). The Contractor shall copy Harris County Public Infrastructure, Engineering Division on all RFI documents. No additional compensation to the Contractor will be allowed for delays resulting from late requests for clarifications. Responses to RFI's will not be binding on Harris County until confirmed in writing by the Architect.

B. Field Modifications:

No person shall have the authority to verbally alter the requirements of the contract documents. No field modifications will be binding on Harris County unless confirmed in writing from the Architect, or documented, signed and dated by the Architect on the set of "Record Drawings" in the field office.

Changes in Contract:

1. All proposed costs for a change in contract must be supported by itemized accounting of material, equipment and labor in sufficient detail to allow value analysis by the Architect using current cost estimating guides prevalent in the area. Harris County shall have up to fourteen (14) calendar days from date of receipt of written proposal for review and approval by the Architect.

2. For general construction work, the Contractor will be allowed the actual cost for materials from supply houses, the total amount of wages paid for labor, and the total cost of Federal Old Age Benefits (Social Security Tax) and of Worker's Compensation and Public Liability Insurance, plus cost of Bond if the size of the change warrants revision of the bonds. To the total of the above costs, the Contractor will be allowed to add a percentage as noted below to cover overhead and profit combined. Overhead shall be considered to include insurance other than mentioned herein, field and office supervisors, Project Managers and assistants, clerical work, use of small hand tools, incidental job burdens (i.e. telephone, electricity, dumpster costs) and general home office expense, and no separate allowance will be made therefor. Allowable percentages for overhead and profit on changes shall not exceed 15%. In no way shall the cumulative cost burden to Harris County for overhead and profit exceed 15% including the General Contractor and his Subcontractors combined.

3. On changes involving both additions and deletions, percentages for overhead and profit will be allowed only on the net addition.

C. Separate Construction by Harris County:

Harris County may administer separate construction contract(s) on this project site simultaneously. Harris County may coordinate the separate contracts and the Contractor shall extend full cooperation towards successful execution of all separate contracts.

D. Preservation and Restoration of Property:

Harris County reserves the right to repair damages to existing property made necessary through an act, omission or misconduct, or in consequence of the non-performance of the Work on the part of the Contractor, his employees or subcontractors, if the Contractor fails to respond to written demand for the repair within 24 hours of such notification. Repairs made by the County on the Contractor's behalf shall be reimbursed by the Contractor to the County or said costs of repairs may be deducted from amounts owed to the Contractor.

E. Commissioning:

Commissioning of the facility shall occur prior to substantial completion. The commissioning process shall include representatives from the Design Team, Contract Administration and County Agencies responsible for the operation and maintenance of the facility.

F. Substantial Completion:

Substantial Completion occurs when the project can be occupied and used for its intended purpose. Substantial completion occurs when all mechanical, electrical and plumbing systems and fixtures are operational and the building or portion of the building can be occupied for its intended purpose. Factors such as the lack of door hardware, security features, life safety devices, fire and smoke alarm testing, and too many other aspects too numerous to list may mitigate against a project being substantially complete for the purpose of stopping the contract time. The Architect shall issue a substantial completion certificate setting forth a time limit for remedying the punch list items, as determined by the Architect. The substantial completion certificate effectively stops the contract time. Failure of the Contractor to complete punch list items within the time limit shall result in the assessment of liquidated damages being assessed against the contract in an amount equal to one half of the liquidated damages applicable to delays prior to substantial completion. Warranty periods and dates for the owner to assume responsibility for utilities, shall be the date of substantial completion.

G. Warranties:

1. All items having a manufacturer's warranty installed under this contract shall be installed by or under the directive of the manufacturer or his certified agent in order to conform with the manufacturer's warranty requirements. All work involving manufacturer's products shall be performed in accordance with manufacturer's recommendations in order to maintain all warranties.

2. Immediately prior to expiration of the one (1) year standard warranty period, or any extended warranty such as roofing, the Contractor shall make an inspection of the Work in the company of the Architect. The Architect shall be given not less than fourteen (14) calendar days notice prior to the anticipated date of warranty

expiration.

3. Where any portion of the Work has proven to be defective and requires replacement, repair or adjustment, the Contractor shall immediately provide materials and labor necessary to remedy such defective Work and shall prosecute such Work without delay until completed to the satisfaction of the Architect, even though the date of completion of the corrective work may extend beyond the expiration date of the warranty period.

END OF SECTION

SECTION 00 31 00
AVAILABLE PROJECT INFORMATION

PART 1 GENERAL

1.01 EXISTING CONDITIONS

A. Certain information relating to existing surface and subsurface conditions and structures is available to bidders but will not be part of Contract Documents, as follows:

B. Geotechnical Report:
   1. A copy is included with this document.
   2. This report identifies properties of below grade conditions and offers recommendations for the design of foundations, prepared primarily for the use of Architect.
   3. Report Title: Geotechnical Investigation New Mathews Community Center for Harris County Precinct 3. Tomball, Harris County, Texas
      a. Date: March 26, 2026
      b. Number of Pages: 72 pages
      c. Prepared by: Geotest Engineering, Inc.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

3.01 DISCLAIMER

A. By executing the Agreement, the Contractor accepts responsibility for subsequent action taken based upon his conclusions drawn from information listed above. Neither Owner nor Architect assumes any responsibility for conclusions Contractor may draw therefrom.

END OF SECTION

SECTION 01 11 10
CODES, REGULATIONS AND STANDARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section specifies requirements for the following:
   1. References Standards.
   2. Definitions.
   3. Abbreviations.
   4. Format and Specification Context Explanations.
   5. Drawing Symbols.
   6. General Requirements.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.
   1. Related Sections include:
      a. Division 01 Section “References” for definitions other than basic definitions included in the Conditions of the Contract and industry standards.
      b. Divisions 02 through 48 Sections for specific definitions, regulations, and standards applicable to individual parts of the Work.

1.03 QUALITY ASSURANCE

A. This Section outlines only minimum standards and requirements. Refer to the Drawings and other sections of the specifications for additional requirements. Bring all conflicts and discrepancies to the attention of the Architect and appropriate Conultants, and do not start work until such conflicts and discrepancies are clarified and corrected.

B. General:
   1. For products or workmanship specified by a standard of an association, trade, or Federal standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable code authorities having jurisdiction.
   2. The contractual relationship of the parties to the Contract should not be altered from the Contract Documents by mention or inference otherwise in any reference standard.
   3. Obtain copies of standards when required by Contract Documents.
   4. Maintain copy of standards at jobsite during submittals, planning, and progress of the specific work for which the standards pertain, until the date of Substantial Completion.
   5. In the absence of specific instructions in the specifications, materials, products, equipment and their installation shall conform to the applicable codes, regulations and standards specified therein. When a conflict exists between the applicable code, regulation and standard and that specified, the more stringent code regulation or standard shall prevail, except as authorized by applicable authorities having jurisdiction.

C. Specifications and Drawings: The Drawings and Specifications are correlative and have equal authority and priority. Base disagreements in themselves or in each other on the most expensive combination of quantity and quality of work indicated. In the event of such disagreement bring it to the attention of the Architect, who will determine the appropriate method to perform the work.

D. Industry Standards: Where compliance with two (2) or more industry standards or sets of requirements are specified, and overlapping of those different standards or requirements

establishes different or conflicting minimums or levels of quality, the most stringent requirement is intended and will be enforced, unless specifically detailed language written into Contract Documents clearly indicates that a less stringent requirement is to be fulfilled. Refer apparently equal-but-different requirements, and uncertainties as to which level of quality is more stringent, to the Architect for a decision before proceeding.

E. Contractor's Option: Except for overlapping or conflicting requirements, where more than one (1) set of requirements are specified for a particular unit of work, option is intended to be Contractor's regardless of whether or not it is specifically indicated as such.

F. Minimum Quality/Quantity: In every instance, the quality level or quantity shown or specified is intended to be the minimum for the work to be performed or provided. Except as otherwise specifically indicated, the actual work may either comply exactly with the minimum (within specified tolerances), or may exceed that minimum within reasonable limits. In complying with requirements, indicated numeric values are either minimums or maximums as noted or as appropriate for context of requirements. Refer instances of uncertainty to Architect for decision before proceeding.

G. Specialists; Assignments: In certain instances, specification text requires (or implies) that specific work is to be assigned to specialists, who are engaged for performance of work. Such assignments shall be recognized as special requirements over which the Contractor has no choice or option. These requirements should not be interpreted so as to conflict with applicable regulations, union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of work is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of requirements remains with the Contractor.

1.04 REFERENCE STANDARDS

A. Dates of codes, regulations and standards specified shall be the latest date of issue of that code, regulation or standard prior to the date of issue of this Project Manual or Document, except as modified or otherwise directed by the applicable codes and their supplements and amendments adopted by the code authorities having jurisdiction.
   1. Date of Issue - The "date of issue" as it appears in the statement above, means the date which appears on the cover of the Project Manual or Document corresponding to the date of issue of the Contract Documents.
   2. Code Authorities: The "code authorities" as it appears in the statement above, means the Building Code authorities responsible for code enforcement.

B. Governing Codes:
   1. Building/Structural Code: 2021 International Building Code (IBC) with 2024 Harris County Amendments.
   2. Plumbing Code: State of Texas adopted International Plumbing Code.
   3. Mechanical Code: State of Texas adopted International Mechanical Code.
   4. Electrical Code: State of Texas adopted 2020 NFPA 70.
   5. Fire Code: 2021 International Fire Code (IFC) with 2024 Harris County Amendments.
   6. Accessibility Standards: 2012 Texas Accessibility Standards (TAS).

C. Governing Guidelines:
   1. Harris County Standards.

1.05 DEFINITIONS

A. General Explanation: A substantial amount of specification language consists of definitions for terms found in other Contract Documents, including those in the AIA A201 General Conditions of the Contract for Construction, Supplementary Conditions, the Drawings, and the Specifications. Drawings must be recognized as being diagramatic in nature and not completely descriptive of requirements indicated thereon. Certain terms used in the Contract Documents are defined in the General Conditions, Supplementary Conditions, and in this Section.

Definitions and explanations contained in this Section are not necessarily either complete or exclusive, but are general for this Work to the extent that they are not stated more explicitly in another element of the Contract Documents. In the event of a conflict in definitions or explanations within the Contract Documents or whenever there is need of clarification or interpretation of definitions within or between the Contract Documents, notify the Architect immediately and proceed as directed. Except in cases where definitions are determined by code authorities having jurisdiction, the Architect's interpretation of all definitions will take precedence.

B. General Conditions: Wherever the term "General Conditions", appears in the Contract Documents, it refers collectively to all requirements of the Uniform General Conditions for Harris County's General Conditions for Building Construction and Related Work and as determined by the Owner applies to entire Work.

C. Special Conditions: Wherever the term "Special Conditions", appears in the Contract Documents, it refers collectively to all requirements of the Owner in addition to the sections in Division 01, General Requirements, and to Articles contained in the General Conditions and Supplementary Conditions, if any.

D. General Requirements: The provisions or requirements of Division 01 - Sections apply to entire Work of Contract and, where indicated, to other elements which are included in the Project.

E. Owner, Client, etc.: Wherever the term "Owner", "Client", or similar term appears in the Contract Documents, it means the entity (person or firm) listed as such in the Project Directory. All communications to the Owner shall be directed and addressed through the Architect listed below, unless directed otherwise.

F. Architect, etc.: Wherever the term "Architect", or any derivative thereof appears in the Contract Documents, it means the entity (person or firm) listed as such in the Project Directory.

G. Bid, Competitive Proposal, Response, Offer, etc.: Wherever the term "Bid", "Competitive Proposal", "Response", "Offer", "Proposal", or any derivative thereof, or similar term appears in the Contract Documents, they mean one and the same, and shall mean Bid.

H. General Contractor, Contractor, etc.: Wherever the term "General Contractor", "Contractor", "Bidder", "Bidder/Vendor", "Vendor", "Installer", "Integrator", "Respondent", "Offeror", or any derivative thereof, or similar term appears in the Contract Documents, they mean one and the same, and shall refer to the entity (person or firm) licensed and meeting all applicable regulations of the State of Texas and Department of Labor to perform the Work, or their authorized representative(s).
    1. Responsibilities: To avoid any misunderstanding or lack of interpretation, the Contractor is hereby advised that the responsibility for the coordination and performance of the work, either by its own forces, or that of its subcontractor(s) is totally his, and such responsibility shall be demonstrated throughout the Work and specified warranty period.
    2. In the event of a controversy involving the Contract Documents or interpretation of Project requirements, the decision of the Architect will take precedence.

I. Subcontractor, Sub-subcontractor, Bidder, etc.: Wherever the term "Subcontractor", Sub-subcontractor", "Bidder", "Vendor", "Installer", "Integrator", "Respondent", "Offeror", "Proposer", or any derivative thereof, or similar term appears in the Contract Documents, they mean one and the same, and shall refer to the entity (person or firm) licensed and meeting all applicable regulations of the State of Texas and Department of Labor to perform the Work, or their authorized representative(s).
    1. Responsibilities: To avoid any misunderstanding or lack of interpretation, the responsibility for performing the work is totally that of the entity defined above, and the resolutions proposed in his shop drawings and related documentation shall be demonstrated throughout the Work and specified warranty period.

J. Consultant: Wherever the term "Consultant", or any derivative thereof appears in the Contract Documents, it means the entity (person or firm) listed as such in the Project Directory.

K. Indicated: Wherever the term “indicated”, or any derivative thereof appears in the Contract Documents, it means a cross-reference to graphic representations, notes, or schedules on Drawings, to other paragraphs or schedules in the Specifications, and to similar means of recording requirements in the Contract Documents. Where terms such as “shown”, “noted”, “scheduled”, and “specified” are used in lieu of “indicated”, it is for the purpose of helping reader locate cross-reference, and no limitation of location is intended except as specifically noted.

L. Directed, Requested, Etc: Where not otherwise explained, terms such as “directed”, “requested”, “authorized”, “selected”, “approved”, “required”, “accepted”, and “permitted” or any derivative thereof appears in the Contract Documents, it means as “directed by the Architect”, “requested by the Architect”, and similar phrases with actions taken by the Architect. However, no meaning or otherwise shall be interpreted to extend the Architect’s responsibility into Contractor’s area of construction supervision.

M. Approve: Wherever the term “Approve”, or any derivative thereof appears in the Contract Documents, it means only the Architect, or an individual designated by him as his representative, can approve or disapprove contract actions. Even if the specifications indicate that an individual other than the Architect, such as the “Engineer” or “Consultant” will approve or disapprove an action, it is understood that only the Architect has this authority unless the individual is so designated by him in writing. Even when an individual is so designated, the Contractor may appeal the action to the Architect and the Architect’s decision will be final. In no case will “approval” by the Architect be interpreted as a release of the Contractor from responsibility to fulfill requirements of the Contract Documents.

N. Furnish: Wherever the term “Furnish”, or any derivative thereof appears in the Contract Documents, it means supply or deliver to Project site, ready for unloading, unpacking, assembly, erection, placing, installing, anchoring, applying, curing, finishing, protecting, cleaning and similar operations, as applicable in each instance.

O. Install: Wherever the term “Install”, or any derivative thereof appears in the Contract Documents, it means performing the operations at the Project site, of unloading, unpacking, assembly, erection, placing, installing, anchoring, applying, curing, finishing, protecting, cleaning and similar operations, as applicable in each instance.

P. Provide: Wherever the term “Provide”, or any derivative thereof appears in the Contract Documents, it means furnish and install at the Project site, complete and ready for intended use, as applicable in each instance.

Q. Project, Site: Wherever the term “Project”, “Site”, or similar such term appears in the Contract Documents, it means the space available to the Contractor for performance of the Work, either exclusively or in conjunction with others performing work as part of the Project. The extent of project or site is shown on the Drawings, and may or may not be identical with description of land upon which Project is to be built.

R. Installer: Wherever the term “Installer”, or any derivative thereof appears in the Contract Documents, it means the entity (person or firm) engaged by the Contractor or its subcontractor or sub-subcontractor for performance of a particular unit of work at the Project, including installation, erection, application and similar required operations. It is a general requirement that such entities (Installers) be expert in operations they are engaged to perform.

S. Specialist: Wherever the term “Specialist”, or any derivative thereof appears in the Contract Documents, it means an individual or firm of established reputation (or if newly organized, whose personnel have previously established a reputation in the same field), which is regularly engaged in, and which maintains a regular force of workmen skilled in either (as applicable) manufacturing or fabricating items required by the Contract, installing items required by the Contract, or otherwise performing work required by the Contract. Where the Contract Specification requires installation by a specialist, that term shall also be deemed to mean either the manufacturer of the item or firm who will perform the work under the manufacturer’s direct supervision.

T. Testing Laboratory: Wherever the term “Testing Laboratory”, or any derivative thereof appears in the Contract Documents, it means an independent entity engaged to perform specific inspections or tests of the work, either at the Project site or elsewhere; and to report and (if required) interpret results of those inspections or tests.

1.06 FORMAT AND SPECIFICATION CONTEXT EXPLANATIONS

A. Underscoring: Is used strictly to assist reader of specification text in scanning text for key words (for quick recall). No emphasis on or relative importance is intended where underscoring is used.

B. Capitalization: Except for manufacturer, product, or trademark names, capitalization is used strictly to assist reader of specification text in scanning text for key words (for quick recall). No emphasis on or relative importance is intended where capitalization is used.

C. Imperative language: Is used generally in specifications. Except as otherwise indicated, requirements expressed imperatively are to be performed by Contractor. For clarity of reading at certain locations, contrasting subjective language is used to describe responsibilities which must be fulfilled indirectly by the Contractor, or when so noted, by others.

D. Section Numbering: Is used to facilitate cross-reference in Contract Documents. Sections are placed in Project Manual in numeric sequence; however, numbering sequence is not complete, and listing of sections at beginning of Project Manual must be consulted to determine numbers and names of specification sections in Contract Documents.

E. Page Numbering: Pages are numbered independently for each section. The section number is shown preceded by the project number and followed by the page number at the bottom of each page, to facilitate the location of text. The project number is given to identify the project, for which specification was written, should the section become separated from the Project Manual.

F. Specifying Methods: The techniques or methods of specifying to record requirements varies throughout text, and may include “prescriptive, “open-generic descriptive”, “compliance with standards”, “performance”, or a combination of these. The method used for specifying one unit of work has no bearing on requirements for another unit of work.

G. Abbreviations: The language of Specifications and other Contract Documents is of the abbreviated type in certain instances, and implies words and meanings which will be appropriately interpreted. Actual work abbreviations of a self-explanatory nature have been included in texts. Specific abbreviations have been established, principally for lengthy technical terminology and primarily in conjunction with coordination of specification requirements with notations on drawings and in schedules. These are frequently defined in section at first instance of use. Trade association names and titles of general standards are frequently abbreviated. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of the Contract Documents so indicates. A list of typical abbreviations, includes, but is not limited to the following trade associations and organizations. Refer to Drawings and other Contract Documents for other abbreviations.

1. AA Aluminum Association
2. AAMA Architectural Aluminum Manufacturer's Assn.
3. AASHTO American Association of State Highway and Transportation Officials ACI American Concrete Institute
4. ACIL American Council of Independent Laboratories AGA American Gas Association
5. AGC Associated General Contractors of America AHA American Hardboard Association
6. AHGA American Hotdip Galvanizers Association AI Asphalt Institute
7. AIA American Institute of Architects
8. AISC American Institute of Steel Construction AISI American Iron & Steel Institute
9. AITC American Institute of Timber Construction ANSI American National Standards Institute APA American Plywood Association
10. ARI Air Conditioning & Refrigeration Institute
11. ASA Acoustical Society of America

12. ASA American Subcontractors Association
13. ASC Adhesive & Sealant Council, Inc. ASCE American Society of Civil Engineers
14. ASME American Society of Mechanical Engineers ASPE American Society of Professional Engineers
15. ASAHC American Society of Architectural Hardware Consultants ASHRAE American Society of Heating, Refrigeration, and Air Conditioning
    1) Engineers
16. ASPI American Wood Preserver's Institute
17. ASTM ASTM International (American Society for Testing and Materials) AWI Architectural Woodwork Institute
18. AWS American Welding Society
19. BHMA Builders Hardware Manufacturers Association, Inc. BIA Brick Institute of America
20. BRI Building Research Institute
21. CRA California Redwood Association
22. CLFMI Chain Link Fence Manufacturers Institute CRSI Concrete Reinforcing Steel Institute
23. CSI Construction Specifications Institute
24. DHI Door and Hardware Institute
25. EPA Environmental Protection Agency
26. FTI Facing Tile Institute
27. FGMA Flat Glass Marketing Association GA Gypsum Association
28. HPMA Hardwood Plywood Manufacturers Association IBC International Building Code
29. ICBO International Conference of Building Officials IEEE Institute of Electrical and Electronic Engineers JSMA Joint Sealer Manufacturers Association
30. LEED Leadership in Energy & Environmental Design MFMA Maple Flooring Manufacturers Association ML/SFA Metal Lath/Steel Framing Association
31. NAAMM National Association of Architectural Metal Manufacturers NAMM National Association of Mirror Manufacturers
32. NBLP National Bureau of Lathing & Plastering NCPI National Clay Pipe Institute
33. NCMA National Concrete Masonry Association NEMA National Electrical Manufacturers Assn. NESC National Environmental Systems Contractors NFPA National Fire Protection Association
34. NFPA National Forest Products Association NHLA National Hardwood Lumber Association
35. NOMMA National Ornamental Metal Manufacturers Assn NPVLA National Paint, Varnish and Lacquer Assn.
36. NRMCA National Ready Mixed Concrete Assn. NRCA National Roofing Contractors Association NSPE National Society of Professional Engineers
37. NWMA National Woodwork Manufacturers Assn., Inc. OSHA Occupational Safety and Health Administration PDCA Painting and Decorating Contractors of America PI Perlite Institute, Inc.
38. PCA Portland Cement Association
39. RFCI Resilient Floor Covering Institute
40. RVFC Rubber and Vinyl Floor Council SFPA Southern Forest Products Association
41. SHLMA Southern Hardwood Lumber Manufacturing Assn.
42. SDI Steel Deck Institute
43. SDI Steel Door Institute
44. SJI Steel Joist Institute
45. SSPC Steel Structures Painting Council
46. TCA Tile Council of America, Inc.
47. UL Underwriter's Laboratories, Inc. USGBC U. S. Green Building Council VBI Venetian Blind Institute

48. VFI Vinyl Fabrics Institute
49. WCLIB West Coast Lumber Inspection Bureau WRCLA Western Red Cedar Lumber Association WWPA Western Wood Products Association

1.07 DRAWING SYMBOLS

A. General: Except as otherwise indicated, graphic symbols used on drawings are those symbols recognized in the construction industry for purposes indicated. Where not otherwise noted, symbols defined by “Architectural Graphic Standards”, published by the American Institute of Architects (AIA) and John Wiley & Sons, Inc., latest edition. Refer instances of uncertainty to Architect for clarification before proceeding.

B. Mechanical/Electrical Drawings: Graphic symbols used in Mechanical/Electrical Drawings are generally aligned with symbols recommended by American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE). Where appropriate, those symbols are supplemented by more specific symbols as recommended by other recognized technical organizations, including, but not limited to American Society of Mechanical Engineers (ASME), American Society of Professional Engineers (ASPE), Institute of Electrical and Electronic Engineers (IEEE) and similar organizations. Refer instances of uncertainty to Architect for clarification before proceeding.

1.08 GENERAL REQUIREMENTS

A. Color, Texture, or Pattern Requirements:
   1. When color, texture, or pattern is specified, the item, product, or material shall be furnished in the specified color, texture, or pattern, as applicable.
   2. When more than one (1) approved manufacturer is named in the Specifications, Contractor may select any of the approved manufacturers and submit the full range of colors, textures, and patterns (standard and special) available of that manufacturer for the Architect’s review and selection.
   3. When the term “match Architect’s approved sample”, or any derivative thereof appears in the Contract Documents, it means that the Architect has selected a sample which must be matched in every respect as to color, texture, and pattern, as applicable.
   4. When an item or product is specified of a manufacturer for which only one (1) color, texture, or pattern is available, and a color, texture, or pattern other than that one is specified, Contractor shall bring it to the attention of the Architect for a decision prior to proceeding with the work. Do not proceed with the work until Architect has approved the color, texture, and pattern, as applicable.
   5. When an item or product is specified of a manufacturer for which no color, texture, or pattern is specified, and colors, textures, and patterns are available, Contractor shall bring it to the attention of the Architect and submit the full range of colors, textures, and patterns (standard and special) available of that manufacturer for the Architect’s review and selection. Do not proceed with the work until Architect has selected and approved the color, texture, and pattern, as applicable.
   6. When due to the nature of the item, product, or material, i.e. tile, etc, Contractor shall submit sample or samples which exhibits the full range of characteristics (colors, i.e. lights and darks, as well as textures, and patterns) for which the item, product, or material is available. The Architect will select the color, texture, and pattern, as applicable, from those available and request a sample panel exhibiting the approved characteristics. The approved color range, texture, and pattern, as applicable will then become the standard for which all work on the project will be judged. Architect will be final judge as to having performed work in conformance with approved characteristics.
   7. Under no circumstances are colors, textures, patterns, or any other characteristics for which an item, product, or material are available to be selected by anyone other than the Architect or his authorized representative.
   8. Non-conforming work shall be removed from the site and replaced with new conforming work at no additional expense to Owner.

B. Continuity of Building Envelope, Full Height Partitions, and Fire Rated Construction:
   1. Continuity of Building Envelope:
      a. All materials such as exterior sheathing, membrane flashings, vapor barriers, insulations, dampproofing, waterproofing, roofing, flashings, etc. and all penetrations, holes, gaps, joints, and openings through such
         1) materials shall be sealed to ensure continuity of building envelope, whether indicated or not to eliminate moisture penetration.
      b. Refer instances of uncertainty to Architect for clarification before proceeding with work.
   2. Full Height Partitions:
      a. All full height partitions shall be from floor to bottom of deck structure and shall be made to fit around steel joists, beams, etc., whether indicated or not.
      b. Seal joints at top of partitions, in flutes of steel deck, and around structural elements with a compressible filler and/or sealant to accommodate movement due to expansion, contraction, and deflection, whether indicated or not. Treat seals in joints of fire rated partitions as specified below for fire rated construction, whether indicated or not.
      c. Refer instances of uncertainty to Architect for clarification before proceeding with work.
   3. Fire Rated Construction:
      a. All seals in fire rated construction, whether at top, bottom, or penetrations through fire rated construction, shall be made with firestopping and fire safing materials to maintain fire rating integrity of construction and satisfy authorities having jurisdiction, whether indicated or not.
      b. Refer instances of uncertainty to Architect for clarification before proceeding with work.

C. Plumbing Line Protection:
   1. Placing or washing materials, including, but not limited to the following, down any plumbing line or fixture is strictly forbidden.
      a. Concrete, cement, sludge, mortar, grout, plaster, or any other cementitious material
      b. Paint, paint thinner, turpentine, kerosene, gasoline, oil, or any other petroleum or hazardous products.
   2. Cleaning painting equipment, including brushes in new or existing plumbing fixtures is strictly prohibited.
   3. If requested, Contractor shall certify that all affected plumbing lines and fixtures are clean, free flowing and running. Plumbing lines and fixtures damaged as a result of any of the above shall be repaired or replaced at no expense to Owner. Contractor shall bear responsibility and all costs of fines, penalties, and legal fees attributed to violations as levied by authorities having jurisdiction.

D. Support from Structure: Ducts, pipes, conduits, equipment, and other items indicated to be supported from the structure shall be accomplished using approved hangwires, hangers, or devices of type, size and material recommended to suit the application and installed in accordance with recommendations of the hanger or device manufacturer, Architect and/or Structural Engineer, or code authorites having jurisdiction, whichever is the more stringent
   1. requirement. Nothing shall be hung from the structure unless directed to do so by the Architect and/or Structural Engineer.

E. Ducts, Pipes, Conduits, and Wires: Shall be concealed in walls, chases, and enclosed areas out of view, unless specifically indicated as exposed or where exposure is required for proper function of item, such as air registers, air returns, louvers, grilles, vents, thermostats, electrical receptacles, telephone/data terminals and jacks, light switches, etc. Refer instances of uncertainty to Architect for clarification before proceeding.

F. Fasteners:

1. Unless specifically indicated or directed otherwise, all fasteners in work exposed to view, shall be concealed in the finished work.
2. No fasteners shall show through or telegraph through exposed face of finished work and all finished surfaces shall be free of all evidence of the existence of fasteners.
3. Fasteners shall be spaced to accurately and rigidly secure work in place.
4. If not shown or otherwise required or recommended by manufacturer, standard, or code authorities having jurisdiction, fastener spacing shall not exceed 12 inches on center.
5. Non-conforming work shall be removed from the site and replaced with new conforming work at no additional expense to Owner.

G. Exposed Metal Work:
1. Unless specifically indicated or directed otherwise, all exposed metal work shall be flat with all surfaces free of distortions, oil canning, waves, dents, scratches, weld marks, and other surface defects detrimental to good appearance or function.
2. All steel exposed to exterior shall be hot-dip galvanized, phosphate treated for paint retention and shop prime painted.
3. Non-conforming work shall be removed from the site and replaced with new conforming work at no additional expense to Owner.

PART 2 - PRODUCTS

2.01 NOT USED PART 3 - EXECUTION

A. Not Used

END OF SECTION

SECTION 01 21 00
ALLOWANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Section includes administrative and procedural requirements governing allowances. Types of allowances include lump-sum allowance.

1.02 DEFINITIONS

A. Allowance: A dollar amount established in lieu of additional requirements, used to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.

1.03 SELECTION AND PURCHASE

A. At the earliest practical date after award of the Contract, advise Architect of the date when final selection, or purchase and delivery, of each product or system described by an allowance must be completed by the Owner to avoid delaying the Work. Contractor to include these milestone dates in the Project Schedule.

B. At Architect's request, obtain proposals for each allowance for use in making final selections.

C. Include recommendations that are relevant to performing the Work.

D. Purchase products and systems selected by Architect from the designated supplier.

1.04 SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances in the form specified for Change Orders.

B. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

1.05 INSPECTION AND TESTING ALLOWANCES

A. Inspection and testing allowances include the cost of engaging the inspection or testing agencies, the actual inspections and tests, and reporting the results.

B. These allowances do not include incidental labor required to assist the testing agency or costs for retesting upon failure of previous tests and inspections. Such costs shall be included in Contractor’s bid amount.

1.06 COUNTY-CONTROLLED CONTINGENCY ALLOWANCES

A. County-Controlled Contingency Allowance shall be used only as directed by County Authorized Representative for County’s purposes and only by Change Orders that indicate amounts to be charged to the Allowance.

B. Change Orders authorizing the use of funds from the County-Controlled Contingency Allowance will include Contractor’s related costs and reasonable overhead and profit margins.

1.07 COORDINATION

A. Contractor shall coordinate allowance items with other portions of the Work.

1.08 ADJUSTMENT OF ALLOWANCES

A. County-Initiated Adjustment of Allowances:
   1. County Authorized Representative may, at its sole and exclusive discretion, move available allowance funds from one allowance to another.
   2. County Authorized Representative shall be responsible for notifying both Engineer/Architect and Contractor of any County-initiated adjustments of allowances.

B. Contractor Requested Adjustments of Allowances:

1. To request adjustment of allowance amounts, Contractor shall prepare and submit a proposal based on the difference between the purchase amount and the allowance.
    a. Contractor shall include installation costs in the purchase amount only where indicated as part of the allowance.
    b. If requested by County Authorized Representative, Contractor shall prepare an explanation with supporting documentation to substantiate the distribution of overhead costs and other margins claimed.
2. County Authorized Representative reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
3. If County Authorized Representative agrees to adjust an allowance, County Authorized Representative shall be responsible for notifying both Engineer/Architect and Contractor of the adjustment.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Contractor shall examine products covered by an allowance promptly on delivery for damage or defects. Contractor shall return damaged or defective products to manufacturer for replacement.

B. Contractor shall coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related Work.

3.02 PREPARATION

A. Contractor shall coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related Work.

3.03 SCHEDULE OF ALLOWANCES

A. Owner Contingency Allowance:
    1. Ten percent of the base proposal lump sum

B. Targeting and Inspecting Allowance: Asbestos and Lead- based paint testing and abatement allowance
    1. Lump Sum of $20,000.

C. Furniture, Fixtures, and Equipment Allowance: Lobby/Lounge furniture, room signs/graphics.
    1. Lump Sum of $50,000

END OF SECTION

SECTION 01 26 00
CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section specifies administrative and procedural requirements for handling and processing Contract modifications.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 MINOR CHANGES IN THE WORK

A. Architect will issue supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, “Architect's Supplemental Instructions”.

1.04 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: The Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
   1. Proposal Requests issued by the Architect are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
   2. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
      a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
      b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
      c. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change.
   1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
   2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
   3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
   4. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

5. Comply with requirements in Division 01 Section “Product Requirements” if the proposed change requires substitution of one product or system for product or system specified.

C. Proposal Request Form: Use AIA Document G709 for Proposal Requests.

1.05 ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, base each Change Order proposal on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
   1. Include installation costs in purchase amount only where indicated as part of the allowance.
   2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
   3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.
   4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the Purchase Order amount or Contractor's handling, labor, installation, overhead, and profit. Submit claims within 21 days of receipt of the Change Order or Construction Change Directive authorizing work to proceed. Owner will reject claims submitted later than 21 days after such authorization.
   1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.
   2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

1.06 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.

1.07 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
   1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
   1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS

2.01 NOT USED

PART 3 - EXECUTION

3.01 NOT USED

END OF SECTION

SECTION 01 27 00
MEASUREMENT AND PAYMENT (UNIT PRICES)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for unit prices.

B. Related Sections: Work of all sections, including Division 01 Sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work

1.03 DEFINITIONS

A. Unit price is an amount proposed and stated on the Proposal Form, as a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.

1.04 PROCEDURES

A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, and applicable overhead and profit.

B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.

C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

D. List of Unit Prices: A list of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS

2.01 NOT USED

PART 3 - EXECUTION

3.01 LIST OF UNIT PRICES

A. Unit Price No. 1 - Soil Excavation:
   1. Description: Unit price for Contractor to provide additional soil excavation required on the Project. Refer to Division 31 Earthwork Sections or Civil and Structural Drawings, as applicable, for materials and requirements.
   2. Unit of Measurement: Per cubic yard of soil excavated. Enter unit price amount on Contractor’s Form.

B. Unit Price No. 2 - Structural Fill and Compaction:
   1. Description: Unit price for Contractor to provide additional structural fill and compaction required on the Project. Refer to Division 31 Earthwork Sections and Civil and Structural Drawings, as applicable, for materials and requirements.
   2. Unit of Measurement: Per lift indicated, in place and compacted. Enter unit price amount on Contractor’s Bid Form.

C. Unit Price No. 3 - Reinforcing Steel and Dowels:
   1. Description: Unit price for Contractor to provide additional reinforcing steel and dowels required on the Project. Refer to Division 03 “Cast-In-Place Concrete” for concrete

reinforcing and Civil and Structural Drawings, as applicable, for materials and requirements.

2. Unit of Measurement: Per pound. Enter unit price amount on Contractor's Bid Form.

D. Unit Price No. 4 - Cast-In-Place Concrete, in place:
   1. Description: Unit price for Contractor to provide additional cast-in-place concrete, in place required on the Project. Refer to Division 03 "Cast-In-Place Concrete and Civil and Structural Drawings, as applicable, for materials and requirements.
   2. Unit of Measurement: Per cubic yard, in place. Enter unit price amount on Contractor's Bid Form.

END OF SECTION

SECTION 01 29 00
PAYMENT PROCEDURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.04 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
   1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:
      a. Application for Payment forms with Continuation Sheets.
      b. Submittals Schedule.
   2. Submit a Schedule of Values break down for general requirements, including, but not limited to supervision, mobilization, bonds and insurance, permits, contractor’s fee, close-out documents, and other items related to general conditions on the Project with Contractor’s proposal and submit the Schedule of Values to Architect at earliest possible date, but no later than seven (7) days before the date scheduled for submittal of initial Applications for Payment.
   3. Subschedules: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values correlated with each phase of payment.

B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values.
   1. Identification: Include the following Project identification on the Schedule of Values:
      a. Project name and location.
      b. Name of Architect.
      c. Architect's project number.
      d. Contractor's name and address.
      e. Date of submittal.
   2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
      a. Related Specification Section or Division.
      b. Description of the Work.
      c. Name of subcontractor.
      d. Name of manufacturer or fabricator.
      e. Name of supplier.
      f. Change Orders (numbers) that affect value.
      g. Dollar value. Round amounts to nearest whole dollar; total shall equal the Contract Sum.

1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

3. Breakdown of the Contract Sum: Provide enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.
   a. Provide at least one line item for each Specification Section or major subcontract.
4. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
   a. Differentiate between items stored on-site and items stored off-site. If specified, include evidence of insurance or bonded warehousing, if required. Indicated location of items stored off-site.
5. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
6. Allowances: Provide a separate line item in the Schedule of Values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
7. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
   a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
8. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.05 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by and paid for by Owner. The Architect will not review the Application for Payment.
   1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction Work covered by each Application for Payment is the period indicated in the Agreement.

C. Payment Application Forms: Use AIA Document G702 and AIA Document G703 Continuation Sheets as form for Applications for Payment.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Owner will return incomplete applications without action.
   1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
   2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

E. Transmittal: Submit 3 signed and notarized original copies of each Application for Payment to Owner by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
   1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

F. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's liens from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application
   1. Submit partial waivers on each item for amount requested, before deduction for retainage, on each item.
   2. When an application shows completion of an item, submit final or full waivers.
   3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
   4. Waiver Delays: Submit each Application for Payment with Contractor's waiver of mechanic's lien for construction period covered by the application.
      a. Submit final Application for Payment with or preceded by final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
   5. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.

G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
   1. List of subcontractors.
   2. Schedule of Values.
   3. Contractor's Construction Schedule (preliminary if not final).
   4. Products list.
   5. Schedule of unit prices.
   6. Submittals Schedule (preliminary if not final).
   7. List of Contractor's staff assignments.
   8. List of Contractor's principal consultants.
   9. Copies of building permits.
   10. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
   11. Initial progress report.
   12. Report of preconstruction conference.
   13. Certificates of insurance and insurance policies.
   14. Performance and payment bonds.
   15. Data needed to acquire Owner's insurance.
   16. Initial settlement survey and damage report if required.

H. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
   1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
   2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

I. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
   1. Evidence of completion of Project closeout requirements.
   2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
   3. Updated final statement, accounting for final changes to the Contract Sum.
   4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims".
   5. AIA Document G706A, "Contractor's Affidavit of Release of Liens".
   6. AIA Document G707, "Consent of Surety to Final Payment".

7. Close-out items, including, but not limited to all warranties, maintenance and operation manuals, demonstration videos, and keys.
8. Evidence that claims have been settled.
9. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
10. Final, liquidated damages settlement statement.

PART 2 - PRODUCTS

2.01 NOT USED PART 3 - EXECUTION

A. Not Used

END OF SECTION

SECTION 01 31 00
PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. General project coordination procedures.
   2. Conservation.
   3. Coordination Drawings.
   4. Administrative and supervisory personnel.
   5. Project meetings.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 COORDINATION

A. Coordination: Coordinate construction operations included in various Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different sections that depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.

B. If necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
   1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid
   1. conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   2. Preparation of Contractor's Construction Schedule.
   3. Preparation of the Schedule of Values.
   4. Installation and removal of temporary facilities and controls.
   5. Delivery and processing of submittals.
   6. Progress meetings.
   7. Preinstallation conferences.
   8. Project closeout activities.

D. Conservation:
   1. Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
   2. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work.

1.04 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures".

B. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
   1. Indicate relationship of components shown on separate Shop Drawings.
   2. Indicate required installation sequences.
   3. Refer to Divisions 21 through 28 for specific Coordination Drawing requirements for mechanical and electrical installations.

1.05 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
   1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
   2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
   3. Minutes: Architect will record significant discussions and agreements achieved. Architect will distribute the meeting minutes to everyone concerned, including Owner and Contractor, within 5 days of the meeting.

B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location.
   1. Conduct the meeting to review responsibilities and personnel assignments. Architect will record and distribute meeting minutes to all participates.
   2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
   3. Agenda: Discuss items of significance that could affect progress, including the following:
      a. Tentative construction schedule.
      b. Phasing.
      c. Critical work sequencing.
      d. Designation of responsible personnel.
      e. Procedures for processing field decisions and Change Orders.
      f. Procedures for processing Applications for Payment.
      g. Distribution of the Contract Documents.
      h. Submittal procedures.
      i. Preparation of Record Documents.
      j. Use of the premises.
      k. Responsibility for temporary facilities and controls.
      l. Parking availability.
      m. Office, work, and storage areas.
      n. Equipment deliveries and priorities.
      o. First aid.
      p. Security.
      q. Progress cleaning.
      r. Working hours.
      s. Rain gauge, photos, and excused delays.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
    a. Contract Documents.
    b. Options.
    c. Related Change Orders.
    d. Purchases.
    e. Deliveries.
    f. Submittals.
    g. Review of mockups.
    h. Possible conflicts.
    i. Compatibility problems.
    j. Time schedules.
    k. Weather limitations.
    l. Manufacturer's written recommendations.
    m. Warranty requirements.
    n. Compatibility of materials.
    o. Acceptability of substrates.
    p. Temporary facilities and controls.
    q. Space and access limitations.
    r. Regulations of authorities having jurisdiction.
    s. Testing and inspecting requirements.
    t. Required performance results.
    u. Protection of construction and personnel.
3. Record significant conference discussions, agreements, and disagreements.
4. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Progress Meetings: Conduct progress meetings at regular intervals. Coordinate dates of meetings with preparation of payment requests.
    1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
    2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
        a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
        b. Review present and future needs of each entity present, including the following:
            1) Interface requirements.
            2) Sequence of operations.
            3) Status of submittals.
            4) Deliveries.

5) Off-site fabrication.
6) Access.
7) Site utilization.
8) Temporary facilities and controls.
9) Work hours.
10) Hazards and risks.
11) Progress cleaning.
12) Quality and work standards.
13) Change Orders.
14) Documentation of information for payment requests.
15) Requested excused delays.

3. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
   a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS

2.01 NOT USED PART 3 - EXECUTION

A. Not Used

END OF SECTION

SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including:
   1. Preliminary Construction Schedule.
   2. Contractor's Construction Schedule.
   3. Submittals Schedule.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
   1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
   2. Predecessor activity is an activity that must be completed before a given activity can be started.

B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

C. Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall Project duration and contains no float.

D. Event: The starting or ending point of an activity.

E. Float: The measure of leeway in starting and completing an activity.
   1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as need-ed to meet schedule milestones and Contract completion date.
   2. Free float is the amount of time an activity can be delayed without adversely af-fecting the early start of the following activity.
   3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

F. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

G. Major Area: A story of construction, a separate building, or a similar significant construction element.

H. Milestone: A key or critical point in time for reference or measurement.

1.04 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures".

B. Qualification Data: For firms and persons specified in “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project

names and addresses, names and addresses of architects and owners, and other information specified.

C. Submittals Schedule: Submit one (1) electronic file in PDF format of schedule. Arrange the following information in a tabular format:
   1. Scheduled date for first submittal.
   2. Specification Section number and title.
   3. Submittal category (action or informational).
   4. Name of subcontractor.
   5. Description of the Work covered.
   6. Scheduled date for final release or approval.

D. Preliminary Construction Schedule: Submit one (1) electronic file in PDF format.

E. Contractor's Construction Schedule: Submit one (1) one (1) electronic file in PDF format of initial schedule.

1.05 QUALITY ASSURANCE

A. Prescheduling Conference: Conduct conference at Project site to comply with require-ments in Division 01 Section “Project Management and Coordination”. Review methods and procedures related to the Preliminary Construction Schedule and Contractor's Con-struction Schedule, including, but not limited to, the following:
   1. Review software limitations and content and format for reports.
   2. Verify availability of qualified personnel needed to develop and update schedule.
   3. Discuss constraints, including phasing, work stages, area separations, interim milestones, and partial Owner occupancy.
   4. Review delivery dates for Owner-furnished products.
   5. Review schedule for work of Owner's separate contracts.
   6. Review time required for review of submittals and resubmittals.
   7. Review requirements for tests and inspections by independent testing and in-specting agencies.
   8. Review time required for completion and startup procedures.
   9. Review and finalize list of construction activities to be included in schedule.
   10. Review submittal requirements and procedures.
   11. Review procedures for updating schedule.

B. Construction Photographs: Contractor shall maintain a digital camera on-site and upon request of Owner provide construction photographs at any time during course of con-struction. Submit photographs to the Owner in electronic format.

1.06 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
   1. Secure time commitments for performing critical elements of the Work from parties involved.
   2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.01 SUBMITTALS SCHEDULE

A. Preparation: Submit an electronic file in PDF format of schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.

1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
2. Initial Submittal: Submit concurrently with preliminary bar-chart schedule. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
    a. At Contractor's option, show submittals on the Preliminary Construction Schedule, instead of tabulating them separately.
3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.02 PRELIMINARY CONSTRUCTION SCHEDULE

A. Bar-Chart Schedule: Submit an electronic file in PDF format to Architect and one hard copy to Owner of preliminary horizontal bar-chart-type construction schedule within seven (7) days of date established for commencement of the work.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.03 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Procedures: Comply with procedures contained in AGC's “Construction Planning & Scheduling”.

B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion and Final Completion.
    1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

C. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
    1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Owner.
    2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
    3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section “Submittal Procedures” in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
    4. Startup and Testing Time: Include not less than 5 days for startup and testing.
    5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for administrative procedures necessary for certification of Substantial Completion.

D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
    1. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 01 Section “Summary of Work.” Delivery dates indicated stipulate the earliest possible delivery date.
    2. Work Restrictions: Show the effect of the following items on the schedule:
        a. Coordination with existing construction.
        b. Limitations of continued occupancies.
        c. Uninterruptible services.
        d. Partial occupancy before Substantial Completion.

e. Use of premises restrictions.
f. Provisions for future construction.
g. Seasonal variations.
h. Environmental control.

3. Area Separations: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
   a. Structural completion.
   b. Permanent space enclosure.
   c. Completion of mechanical installation.
   d. Completion of electrical installation.
   e. Substantial Completion.

E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, interim milestones, Substantial Completion, and Final Completion.

F. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall project schedule.

G. Computer Software:
   1. Prepare schedules using a program that has been developed specifically to manage construction schedules.

2.04 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

A. Gantt-Chart Schedule: Submit an electronic file in PDF format to Architect and one hard copy to Owner of a comprehensive, fully developed, horizontal Gantt-chart-type, Contractor's Construction Schedule within 20 days of date established for the Notice to Proceed. Base schedule on the Preliminary Construction Schedule and whatever updating and feedback was received since the start of Project.

B. Preparation:
   1. Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
   2. For construction activities that require three (3) months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

PART 3 - EXECUTION

3.01 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At bi-weekly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
   1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
   2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
   3. As the Work progresses, indicate Actual Completion percentage for each activity.

B. Distribution: Submit an electronic file in PDF format to Architect and one hard copy to Owner of approved schedule to Owner, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
   1. Post copies in Project meeting rooms and temporary field offices.

2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION

SECTION 01 32 33
PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for:
   1. Preconstruction photographs.
   2. Periodic construction photographs.
   3. Final completion construction photographs.
   4. Preconstruction digital video recordings.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.
   1. Related Sections include:
      a. Division 01 Section “Submittal Procedures” for submitting photographic documentation.
      b. Division 01 Section “Closeout Procedures” for submitting digital media as Project Record Documents at Project closeout.
      c. Division 01 Section “Demonstration and Training” for submitting videotapes of demonstration of equipment and training of Owner's personnel.
      d. Division 02 Section “Structure Demolition” for photographic documentation before building demolition operations commence.
      e. Division 02 Section “Selective Structure Demolition” for photographic documentation before selective demolition operations commence.

1.03 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures".

B. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each digital photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

C. Construction Photographs: Submit two prints of each photographic view within seven (7) days of taking photographs.
   1. Format: 8-by-10-inch smooth-surface matte prints enclosed back to back in clear plastic sleeves that are punched for standard three-ring binder.
   2. Identification: On back of each print, provide an applied label or rubber-stamped impression with the following information:
      a. Name of Project.
      b. Name and address of photographer.
      c. Name of Architect.
      d. Name of Contractor.
      e. Date photograph was taken if not date stamped by camera.
      f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
      g. Unique sequential identifier.
   3. Digital Images: Submit a complete set of digital image electronic files with each submittal of prints on CD-ROM. Identify electronic media with date photographs were taken. Submit images that have same aspect ratio as the sensor, uncropped.

1.04 COORDINATION

A. Auxiliary Services: Cooperate with photographer and provide auxiliary services requested, including access to Project site and use of temporary facilities, including temporary lighting required to produce clear, well-lit photographs without obscuring shadows.

1.05 USAGE RIGHTS

A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

PART 2 - PRODUCTS

2.01 PHOTOGRAPHIC MEDIA

A. Provide images in uncompressed TIFF format, produced by a digital camera with minimum sensor size of 5.0 megapixels, and at an image resolution of not less than 1600 by 1200 pixels.

PART 3 - EXECUTION

3.01 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
   1. Maintain key plan with each set of construction photographs that identifies each photographic location.

B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
   1. Date and Time: Include date and time in file name for each image.
   2. Field Office Images: Maintain one set of images on CD-ROM in the field office at Project site, available at all times for reference. Identify images same as for those submitted to Architect.

C. Before starting construction, take digital photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
   1. Flag construction limits before taking construction photographs.
   2. Take 10 photographs to show existing conditions adjacent to property before starting the Work.
   3. Take 10 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
   4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

D. Periodic Construction Photographs: Take 20 photographs monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.
   1. Exterior Photographs: 12.
   2. Interior Photographs: Not less than 8 per building floor or level.

E. Architect-Directed Construction Photographs: From time to time, Architect will instruct photographer about number and frequency of photographs and general directions on vantage points. Select actual vantage points and take photographs to show the status of construction and progress since last photographs were taken.

F. Final Completion Construction Photographs: Take 16 digital photographs after date of Substantial Completion for submission as Project Record Documents. Architect will direct photographer for desired vantage points.

G. Additional Photographs: Architect may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.

1. Three days' notice will be given, where feasible.
2. In emergency situations, take additional photographs within 24 hours of request.
3. Circumstances that could require additional photographs include, but are not limited to, the following:
    a. Special events planned at Project site.
    b. Immediate follow-up when on-site events result in construction damage or losses.
    c. Substantial Completion of a major phase or component of the Work.
    d. Extra record photographs at time of final acceptance.
    e. Owner's request for special publicity photographs.

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 DEFINITIONS

A. Action Submittals: Written and graphic information that requires Architect’s action.

B. Informational Submittals: Written information that does not require Architect's approval. Submittals may be rejected for not complying with requirements.

1.04 SUBMITTAL PROCEDURES

A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
      a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

B. Submittals Schedule: Comply with requirements in Division 01 Section “Construction Progress Documentation” for list of submittals and time requirements for scheduled performance of related construction activities.

C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal.
   1. Initial Review: Allow 10 days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
   2. Concurrent Review: Where concurrent review of submittals by Architect's consultants, Owner, or other parties is required, allow 15 days for initial review of each submittal.

D. Identification: Place a permanent label or title block on each submittal for identification.
   1. Indicate name of firm or entity that prepared each submittal on label or title block.
   2. Provide a space approximately 4 by 5 inches on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
   3. Include the following information on label for processing and recording action taken:
      a. Project name.
      b. Date.
      c. Name and address of Architect.
      d. Name and address of Contractor.
      e. Name and address of subcontractor.
      f. Name and address of supplier.

g. Name of manufacturer.
h. Unique identifier, including revision number.
i. Number and title of appropriate Specification Section.
j. Drawing number and detail references, as appropriate.
k. Other necessary identification.

E. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals.

F. Additional Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions of the Contract Documents, initial submittal may serve as final submittal.

G. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return submittals, without review received from sources other than Contractor.
1. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.
2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.
3. Transmittal Form: Provide locations on form for the following information:
a. Project name.
b. Date.
c. Destination (To:).
d. Source (From:).
e. Names of subcontractor, manufacturer, and supplier.
f. Category and type of submittal.
g. Submittal purpose and description.
h. Submittal and transmittal distribution record.
i. Remarks.
j. Signature of transmitter.

H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

I. Use for Construction: Use only final submittals with mark indicating action taken by Architect in connection with construction.

1.05 CONTRACTOR’S USE OF ELECTRONIC DRAWING FILES

A. Electronic copies of the construction drawings produced by the Architect may be furnished for Contractor's use in preparing submittals upon request by the Contractor. Requests from subcontractors will not be accepted.
1. Cost: $500.00 per electronic file.
2. The Contractor must submit a single written request for all files to be used; multiple requests by the Contractor may be rejected by the Architect. Request for electronic Drawing files must be accompanied by:
a. Signed copy of the Architect’s “Electronic Media Agreement”. This form is available upon request from the Architect.
b. A list of the name and number of the Drawing sheet as listed on the “Index of Drawings”.
c. Contractor’s preference for form and format of electronic Drawing files.
d. Payment in full.

3. Requested electronic Drawing files will be furnished to the Contractor by the Architect on a CD/DVD or posted to an FTP site at the discretion of the Contractor.
    a. Electronic Drawing files will have necessary x-ref files and layers bound to the electronic Drawing file. A list of layers will not be provided.
    b. Electronic Drawing files will not contain professional seals or company logos.
    c. Electronic Drawing files will be produced using the Architect’s current version of AutoCad. The Contractor may specify that the files be produced in a format useable by an earlier version.
4. By requesting electronic drawing files produced by the Architect, the Contractor acknowledges that:
    a. Contractor is responsible for the accuracy and completeness of the Shop Drawings prepared from these files and submitted in compliance with requirements.
    b. Files are being transmitted as a convenience to the Contractor at the request of the Contractor.
    c. Files were not prepared by the Architect for use as Shop Drawings.
    d. Files may not reflect most current revisions.
    e. Architect is under no obligation to inform the Contractor of subsequent revisions to the files.

B. The Contractor should direct written requests to each design consultant (structural, MEP, etc.) for copies of electronic drawing files produced by their offices.

PART 2 - PRODUCTS

2.01 ACTION SUBMITTALS

A. General: Prepare and submit Action Submittals required by individual Specification Sections.
    1. Number of Written Copies: Submit one copy of each submittal. Architect will return one original and one electronic copy. Mark up and retain one returned copy as a Project Record Document.
    2. Number of Drawing Copies: Submit one original copy of each drawing submittal. Architect will return one original and one electronic copy. The contractor shall be responsible for any additional copies required for distribution. Retain one returned copy as a Project Record Document.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
    1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
    2. Mark each copy of each submittal to show which products and options are applicable.
    3. Include the following information, as applicable:
        a. Manufacturer's written recommendations.
        b. Manufacturer's product specifications.
        c. Manufacturer's installation instructions.
        d. Standard color charts.
        e. Manufacturer's catalog cuts.
        f. Wiring diagrams showing factory-installed wiring.
        g. Printed performance curves.
        h. Operational range diagrams.
        i. Mill reports.
        j. Standard product operating and maintenance manuals.
        k. Compliance with recognized trade association standards.
        l. Compliance with recognized testing agency standards.
        m. Application of testing agency labels and seals.
        n. Notation of coordination requirements.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
   1. Preparation: Include the following information, as applicable:
      a. Dimensions.
      b. Identification of products.
      c. Fabrication and installation drawings.
      d. Roughing-in and setting diagrams.
      e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
      f. Shopwork manufacturing instructions.
      g. Templates and patterns.
      h. Schedules.
      i. Design calculations.
      j. Compliance with specified standards.
      k. Notation of coordination requirements.
      l. Notation of dimensions established by field measurement.
   2. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
   3. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 40 inches.

D. Coordination Drawings: Comply with requirements in Division 01 Section “Project Management and Coordination”.

E. Samples: Prepare physical units of materials or products, including the following:
   1. Comply with requirements in Division 01 Section “Quality Requirements” for mockups.
   2. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
   3. Samples for Verification: Submit one full-size unit or Sample of size indicated, prepared from the same material to be used for the Work, cured and finished in manner specified, and physically identical with the product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
   4. Preparation: Mount, display, or package Samples in manner specified to facilitate review of qualities indicated. Prepare Samples to match Architect's
      a. sample where so indicated. Attach label on unexposed side that includes the following:
      b. Generic description of Sample.
      c. Product name or name of manufacturer.
      d. Sample source.
   5. Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, provide the following:
      a. Size limitations.
      b. Compliance with recognized standards.
      c. Availability.
      d. Delivery time.
   6. Submit Samples for review of kind, color, pattern, and texture for a final check of these characteristics with other elements and for a comparison of these characteristics between final submittal and actual component as delivered and installed.
      a. If variation in color, pattern, texture, or other characteristic is inherent in the product represented by a Sample, submit at least three sets of paired units that show approximate limits of the variations.

b. Refer to individual Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.

7. Number of Samples for Initial Selection: Submit one full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
8. Number of Samples for Verification: Submit one set of Samples. Architect will return Sample set. Mark up and retain returned Sample set as a Project Record Sample.
   a. Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
9. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
   a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
   b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

F. Product Schedule or List: Prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
   1. Type of product. Include unique identifier for each product.
   2. Number and name of room or space.
   3. Location within room or space.

G. Delegated-Design Submittal: Comply with requirements in Division 01 Section “Quality Requirements”.

H. Submittals Schedule: Comply with requirements in Division 01 Section “Construction Progress Documentation”.

I. Application for Payment: Comply with requirements in Division 01 Section “Payment Procedures”.

J. Schedule of Values: Comply with requirements in Division 01 Section “Payment Procedures”.

K. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
   1. Name, address, and telephone number of entity performing subcontract or supplying products.
   2. Number and title of related Specification Section(s) covered by subcontract.
   3. Drawing number and detail references, as appropriate, covered by subcontract.

2.02 INFORMATIONAL SUBMITTALS

A. General: Prepare and submit Informational Submittals required by other Specification Sections.
   1. Number of Copies: Submit one electronic copy of each submittal required. Architect will not return copy.
   2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
   3. Test and Inspection Reports: Comply with requirements in Division 01 Section “Quality Requirements.”

B. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

C. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements.

D. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.

E. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.

F. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.

G. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.

H. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.

I. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements.

J. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

K. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements.

L. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

M. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with 2003 International Building Code with City of Houston Amendments in effect for Project. Include the following information:
   1. Name of evaluation organization.
   2. Date of evaluation.
   3. Time period when report is in effect.
   4. Product and manufacturers' names.
   5. Description of product.
   6. Test procedures and results.
   7. Limitations of use.

N. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 01 Section “Closeout Procedures, Operation, and Maintenance Data”.

O. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load

diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

P. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
   1. Preparation of substrates.
   2. Required substrate tolerances.
   3. Sequence of installation or erection.
   4. Required installation tolerances.
   5. Required adjustments.
   6. Recommendations for cleaning and protection.

Q. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
   1. Name, address, and telephone number of factory-authorized service representative making report.
   2. Statement on condition of substrates and their acceptability for installation of product.
   3. Statement that products at Project site comply with requirements.
   4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
   5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
   6. Statement whether conditions, products, and installation will affect warranty.
   7. Other required items indicated in individual Specification Sections.

R. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.

S. Construction Photographs: Comply with requirements in Division 01 Section “Construction Progress Documentation”.

PART 3 - EXECUTION

3.01 CONTRACTOR'S REVIEW

A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents. Submittal number shall correspond with specification section number. NO EXCEPTIONS.

3.02 ARCHITECT'S ACTION

A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.

B. Action Submittals: Architect will review each submittal, mark to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp, and mark the stamp appropriately to indicate the action taken, as follows:
   1. Final Unrestricted Release: Where the submittal is marked “APPROVED”, the Work covered by the submittal may proceed provided it complies with the Contract Documents. Final acceptance will depend on that compliance.
   2. Final-but-Restricted Release: Where the submittal is marked “APPROVED AS NOTED”, the Work covered by the submittal may proceed provided it complies with both Architect’s

notations and corrections on the submittal and the Contract Documents. Final acceptance will depend on that compliance.

3. Returned for Resubmittal: Where the submittal is marked “NOT APPROVED, REVISE AND RESUBMIT”, do not proceed with the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity for the product submitted. Revise or prepare a new submittal according to Architect’s notations and corrections.
4. Incomplete: Where the submittal is marked “SUBMIT ADDITIONAL INFORMATION”, do not proceed with the Work covered by the submittal. Prepare additional information requested, or required by the Contract Documents, that indicates compliance with requirements. Architect will indicate a number of days within which Contractor is required to submit additional information. When the additional information is not submitted during that period, the submittal may be returned for resubmittal.
5. Other Action: If the submittal is primarily for information purposes, record purposes, special processing, or other contractor activity, the submittal will be returned marked “ACTION NOT REQUIRED”.
6. Informational Submittals: Architect will review each submittal and will not return it, or will reject and return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

C. Do not permit submittals to be used at the Project Site, or elsewhere where Work is in progress that are marked with any one of the following actions:
   1. “NOT APPROVED, REVISE AND RESUBMIT”
   2. “SUBMIT ADDITIONAL INFORMATION”

D. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

E. Informational Submittals: Architect will review each submittal and will not return it, or will reject and return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

END OF SECTION

SECTION 01 35 16
ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes general provisions and requirements pertaining to all remodeling, removal and relocation of Work in the existing building and becomes a part of each Section and Division performing remodeling, removal and relocation work for this Project with the same force and effect as if written in full therein.
   1. Take all necessary precautions to keep trespassers out of the Work areas. Secure Work areas from entry when Work is not in progress.
   2. Perform all alterations, remodeling, demolition, removal and relocation of Work in strict accordance with Owner’s instructions and applicable Federal, State and local health and safety standards, codes and ordinances. Where conflicts occur, the more restrictive requirement shall govern.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.
   1. Related Sections include:
      a. Division 01 Section “Summary of Work”.
      b. Division 01 Section “Photographic Documentation”.
      c. Division 01 Section “Temporary Facilities and Controls”.
      d. Division 01 Section “Cutting and Patching”.
      e. Division 01 Section “Construction Waste Management and Disposal”.
      f. Division 02 Section “Selective Demolition”.

1.03 EXISTING CONDITIONS

A. Obvious existing conditions, installations and obstructions affecting the Work shall be taken into consideration as necessary Work to be done, the same as though they were completely shown or described.

B. Items of existing construction indicated to remain upon completion of the Contract, but which require removal to complete the Work, shall be carefully removed and replaced as required. The replaced Work shall match its condition at the start of the Work unless otherwise required.

C. Visit the site to determine by inspection all existing conditions, including access to the site, the nature of structures, objects and materials to be encountered, and all other facts
   1. concerning or affecting the Work. Information on the Drawings showing existing conditions does not constitute a guarantee that other items may not be found or encountered.

D. Utilities: Do not interrupt existing utilities serving occupied or used facilities, except when authorized by the Architect in writing two (2) weeks in advance. Provide temporary services during interruptions to existing utilities.

1.04 QUALITY ASSURANCE

A. This Section outlines only minimum standards and requirements. Refer to the Drawings and other sections of the specifications for additional requirements. Bring all conflicts and discrepancies to the attention of the Architect or Engineer and do not start work until such conflicts and discrepancies are clarified and corrected.

PART 2 - PRODUCTS

2.01 SALVAGED MATERIALS

A. The Owner reserves the right of first refusal on all salvage items. Remove remaining items from the site as Work progresses. Storage or sale of items on site is not permitted. Burning or burying of removed materials on site is not permitted.

B. Store salvaged items in a dry, secure place on site.

C. Salvaged items not required for use in repair of existing Work shall remain the property of the Owner.

D. Do not incorporate salvaged or used material in new construction except with permission of the Architect.

2.02 PRODUCTS FOR PATCHING, EXTENDING AND MATCHING

A. Contract Documents do not define products or standards of workmanship present in existing construction. Determine products by inspection and by use of the existing. Provide same or similar quality products or types of construction as that in existing structure when needed to patch or extend existing Work.

B. If reasonably matching products are not obtainable, improve appearance by minor relocating of some existing products and grouping new ones in some pattern arranged by the Architect. Do not replace products scheduled for retaining because matching ones are not obtainable, except as directed by Change Order.

PART 3 - EXECUTION

3.01 PROTECTION OF WORK TO REMAIN

A. Protect existing Work from damage. Use barricades, tarpaulins, temporary walls, plywood, planking, masking, or other suitable means and methods as approved by the Architect.

B. If Work to remain in place is damaged, restore to original condition at no additional cost to the Owner.

C. Concealed Conditions: If conditions cause changes in the Work from requirements of the Contract Documents, the Contract Sum will be adjusted in accordance with the General Conditions.

3.02 PROCEDURES

A. Refinishing At Removed Work: Cut below surface of substrate materials and patch over area of removal with finish materials so removal is not apparent.

B. Remove and replace existing ceilings, and cut, patch, or replace existing walls, partitions and floors as may be necessary for access to valves, piping, conduit and tubing by mechanical and electrical trades as directed and approved by the Architect, and performed by the appropriate subcontractor for the Work involved, or by other properly qualified subcontractors.

C. Patch and extend existing Work using skilled mechanics who are capable of matching existing quality and workmanship. Quality of patched or extended Work shall be not less than that specified for new Work.

D. Cutting:
   1. Concrete and Masonry: Saw cut where feasible.
   2. Plaster: Cut back to sound plaster on straight lines, and back-bevel edges of remaining plaster. Trim and prepare existing lath for tying of new lath.
   3. Woodwork: Cut back to a joint or panel line. Undamaged removed materials may be reused.
   4. Resilient Tiles: Remove in whole units to natural breaking points or straight joint lines with no damaged or defective existing tiles remaining where joining new construction. If resilient tiles are suspected or found to contain asbestos, stop all removal activities and

immediately notify Owner to have it properly abated or removed and legally disposed of off site.

5. Salvaged Materials: Carefully remove to avoid damage, thoroughly clean and reinstall as indicated, or as directed.
6. Doors: Remove in such a manner as to facilitate filling in of openings or installation of new Work, as required by Drawings.
7. Structural Elements: Remove only as shown on the Structural Drawings. If not specifically shown, but removal is required, perform such removal or alteration only upon written approval of the Architect. Do not damage or alter any structural element of the existing building.

E. Patching:
1. Match existing Work where possible; if unavailable, use salvage material for patching and provide totally new material in areas where salvage has been removed; consult with the Architect concerning locations for salvaging materials.
2. Repairs or continuations of existing Work shall be relatively imperceptible in the finished Work when viewed under finished lighting conditions from a distance of six (6) feet.
3. Patching, Repairing and Finishing of Existing Work: Perform in compliance with the applicable requirements of the Specification Section covering the Work to be performed and the requirement of this Section.

F. Erect scaffolding as necessary to gain access to the various parts of the Work. Provide structurally sound, rigidly braced and properly constructed scaffolding, shoring and bracing as necessary to positively protect the affected elements and building, and to support the activities or workmen and loads. Design and construction of scaffolds and supports shall be in accordance with applicable safety regulations. Material used shall be adequate to support anticipated loads with a properly calculated margin of safety.

G. Noise Producing Equipment: Minimize use of noise producing equipment. Limit excessive noise to periods of vacancy or provide sound control. Arrange schedules in advance with the Architect.

3.03 EXISTING FURNITURE AND EQUIPMENT

A. Owner Salvaged Items: Personal items in areas subject to remodeling will be removed before construction in those areas commences.

B. Furniture Items: Before remodeling commences, Owner will remove all furniture and equipment from each space, store items as necessary. Owner will replace these items to the same locations after each remodeling phase is complete. Contractor to coordinate activities with Owner.

3.04 PAINTING

A. Preparation: Prepare patched areas as required for new Work. Wash existing painted surfaces with neutral soap or detergent, thoroughly rinse, and sand when dry.

B. Painting and Finishing: Conform to the applicable provisions of the Painting Section. Prepare bare areas and patches in existing painted surfaces with specified primer and intermediate coats, sanded smooth and flush with adjoining surfaces.

3.05 DISPOSAL OF DEBRIS

A. Remove material, debris and rubbish resulting from Work of this Section from the building as it accumulates and legally dispose of off site. Keep all areas of Work in “broom clean” condition as the Work progresses.

B. At completion of renovation and remodeling Work in each area, provide final cleaning and return space to a condition suitable for use by the Owner.

END OF SECTION

SECTION 01 36 00
LAYOUT DATA

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 LAYING OUT AND COMMENCEMENT OF WORK

A. Contractor’s Field Engineer shall ensure adequate quality control and quality assurance for all Work in accordance with Conditions of the Contract, as specified herein, and with the quality control and quality assurance requirements of each Specification Section, and authorities having jurisdiction. Drawings will furnish the Contractor all necessary information to establish line control, and all grades and elevations will refer to a designated benchmark on the site. Contractor shall be responsible for furnishing and setting all construction stakes establishing lines, grades, and elevations for this Project, including underground utilities. Harris County may at their option check the layout.

B. Contractor must satisfy himself, before commencing work, as to the meaning or correctness of all the stakes or marks, and no claim will be entertained for or on account of any alleged inaccuracies, or for alterations subsequently rendered necessary on account of such alleged inaccuracies, unless Contractor notifies Harris County in writing before commencing work thereon. The work as described above will be furnished within 48 hours after written notification to Harris County by the Contractor on the request forms provided by Harris County. Contractor will have a representative on the job site at the time the field work begins.

C. Contractor shall protect stakes, or marks, and pay all costs involved in restaking or remarking.

D. Related Sections: Work of all sections, including Division 01 Sections and Drawings, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

PART 2 - PRODUCTS

2.01 NOT USED PART 3 - EXECUTION

A. Not Used

END OF SECTION

SECTION 01 37 00
SCHEDULE OF VALUES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes furnishing a detailed breakdown of the agreed Contract Sum showing values allocated to each of the various parts of the work, as specified therein and in other provisions of the Contract Documents.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 QUALITY ASSURANCE

A. This Section outlines only minimum standards and requirements. Refer to the Drawings and other sections of the specifications for additional requirements. Bring all conflicts and discrepancies to the attention of the Architect and do not start work until such conflicts and discrepancies are clarified and corrected.

B. Use required means to assure arithmetical accuracy of the sums described.

C. When so required by the Owner, provide copies of the subcontracts or other data acceptable to the Owner, substantiating the sums described.

1.04 SUBMITTALS FOR REVIEW

A. Prior to the first Application for Payment, submit a proposed schedule of values to the Owner and Architect, as outlined below:
   1. Meet with the Owner and Architect and determine additional data, if any, required to be submitted.
   2. Secure the Owner's approval of the schedule of values prior to submitting first Application for Payment.

PART 2 - PRODUCTS

2.01 NOT USED

PART 3 - EXECUTION

3.01 SCHEDULE OF VALUES

A. The Schedule of Values shall be broken down into item costs for each specification section as a minimum. After review by the Owner and Architect, the Schedule of Values shall be broken down into further items as required.
   1. The Schedule of Values shall be subdivided by Areas, to match the drawings. Each trade must break down their amounts by floor plan area.

END OF SECTION

SECTION 01 40 00
QUALITY REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
   1. Specific quality-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
   2. Specified tests, inspections, and related actions do not limit Contractor's quality-control procedures that facilitate compliance with the Contract Document requirements.
   3. Requirements for Contractor to provide quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and ensure that proposed construction complies with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that completed construction complies with requirements. Services do not include contract enforcement activities performed by Architect.

C. Mockups: Full-size, physical example assemblies to illustrate finishes and materials. Mockups are used to verify selections made under Sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples.

D. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

1.04 DELEGATED DESIGN

A. Performance and Design Criteria:
   1. Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   2. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

1.05 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures".

B. Qualification Data: For testing agencies specified in “Quality Assurance” Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

C. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
   1. Specification Section number and title.
   2. Description of test and inspection.
   3. Identification of applicable standards.
   4. Identification of test and inspection methods.
   5. Number of tests and inspections required.
   6. Time schedule or time span for tests and inspections.
   7. Entity responsible for performing tests and inspections.
   8. Requirements for obtaining samples.
   9. Unique characteristics of each quality control service.

E. Required Testing:
   1. Excavation, Site Fill and Grading: When fill is required, Soils Engineering firm shall document that the proposed fill material is acceptable and percentages of compaction are being maintained. Submit copies of test reports to the Architect for review. Do not proceed with building construction until written approval of the fill is given by the Architect.
   2. Soils Tests:
      a. Soil Analysis Method:
         1) Liquid Limit.
         2) Plastic Limit.
         3) Plasticity Index.
         4) Maximum Laboratory Density (Proctor) Tests.
      b. Number of Analysis: One for each type of soil used under structure or pavement.
      c. Field Density Tests: Not less than one set for each 10,000 sq feet. Perform at least 3 tests per set.
   3. Concrete:
      a. Aggregate Tests: Check the proposed aggregate in accordance with ASTM C33.
      b. Mix Design: Check the proposed mixed for proportions, water-cement ratio and clump in accordance with ACI 613 and 318 and with PDA T-12.
      c. Slump Tests: Take at the beginning of each day's pouring operations and when water adjustments or noticeable change of slump occurs, ASTM C 143.
      d. Sampling: Take 4 standard cylinders at the beginning of each pour and 4 additional cylinders for additional 50 cubic yards or fraction thereof. Take extra samples at any noticeable change in the make-up of the concrete. Perform all sampling in compliance with ASTM C 172.
      e. Testing: Cure cylinders in accordance with ASTM C 31. Test 2 cylinders at 7 days and 2 cylinders at 28 days (ATMC C 39). Average the results of the tests.

F. Reports: Prepare and submit certified written reports that include the following:
   1. Date of issue.
   2. Project title and number.
   3. Name, address, and telephone number of testing agency.
   4. Dates and locations of samples and tests or inspections.
   5. Names of individuals making tests and inspections.
   6. Description of the Work and test and inspection method.
   7. Identification of product and Specification Section.
   8. Complete test or inspection data.

9. Test and inspection results and an interpretation of test results.
10. Ambient conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

G. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.06 QUALITY ASSURANCE

A. This Section outlines only minimum standards and requirements. Refer to the Drawings and other sections of the specifications for additional requirements. Bring all conflicts and discrepancies to the attention of the Architect and appropriate Consultants, and do not start work until such conflicts and discrepancies are clarified and corrected.

B. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance.

F. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or products that are similar to those indicated for this Project in material, design, and extent.

G. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
1. Requirement for specialists shall not supersede building codes and similar regulations governing the Work, nor interfere with local trade-union jurisdictional settlements and similar conventions.

H. Testing Agency Qualifications: An agency with the experience and capability to conduct testing and inspecting indicated, as documented by ASTM E 548, and that specializes in types of tests and inspections to be performed.

I. Preconstruction Testing: Testing agency shall perform preconstruction testing for compliance with specified requirements for performance and test methods.
1. Contractor responsibilities include the following:
    a. Provide test specimens and assemblies representative of proposed materials and construction. Provide sizes and configurations of assemblies to adequately demonstrate capability of product to comply with performance requirements.
    b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.

c. Fabricate and install test assemblies using installers who will perform the same tasks for Project.
d. When testing is complete, remove assemblies; do not reuse materials on Project.

2. Testing Agency Responsibilities: Promptly issue a certified written report of each test, inspection, and similar quality-assurance service to Architect, Owner, Structural Engineer and Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

J. Mockups: Before installing portions of the Work requiring mockups, build mockups required to comply with the following requirements, using materials indicated for the completed Work:
1. Construct integrated mockup composed of exterior finishes and materials and constructed to conform to indicated details.
2. Mockup Size: Not more than 10 feet by 10 feet.
3. Conform to the details on the Drawings for construction. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Notify Architect seven days in advance of dates and times when mockups will be constructed.
5. Demonstrate the proposed range of aesthetic effects and workmanship.
6. Obtain Architect's approval of mockups before starting work, fabrication, or construction. Architect’s approval will be for quality of workmanship, material finish, and detailed integration of materials.
7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
8. Demolish and remove mockups when directed, unless otherwise indicated.

1.07 QUALITY CONTROL

A. Owner Responsibilities: Owner will engage a qualified testing agency to perform these services.
1. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.
2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
6. The absence of Owner Provided Testing Services during construction shall not relieve the Contractor from constructing the project in accordance with the Construction Documents. The Contractor shall be responsible for proving and payment of testing services necessary to assure this conformance.

B. Special Tests and Inspections: Owner will engage a testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner.
1. Testing agency will notify Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
2. Testing agency will submit a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
3. Testing agency will submit a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
4. Testing agency will interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
5. Testing agency will retest and reinspect corrected work.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing.

D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that revised or replaced Work that failed to comply with requirements established by the Contract Documents.

E. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
   1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
   2. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
   3. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
   4. Do not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the Work.
   5. Do not perform any duties of Contractor.

F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested.
   1. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
   2. Access to the Work.
   3. Incidental labor and facilities necessary to facilitate tests and inspections.
   4. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
   5. Facilities for storage and field-curing of test samples.
   6. Delivery of samples to testing agencies.
   7. Preliminary design mix proposed for use for material mixes that require control by testing agency.
   8. Security and protection for samples and for testing and inspecting equipment at Project site.

G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.

H. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Submit schedule within 14 days of date established for commencement of the Work.
   1. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

PART 2 - PRODUCTS

2.01 NOT USED PART 3 - EXECUTION

2.02 ACCEPTABLE TESTING AGENCIES

A. To be provided by Owner.

2.03 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Sections of these Specifications. Restore patched areas and extend restoration into adjoining areas in a manner that eliminates evidence of patching.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

SECTION 01 41 00
TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 DESCRIPTION

A. Work Included:
   1. From time to time during progress of the Work, Harris County may require that testing be performed to determine that materials provided for the Work meet the specified requirements; such testing includes, but is not necessarily limited to:
      a. Soil Compaction
      b. Concrete
      c. Grout
      d. Structural Steel
      e. Roof

B. Related Sections: Work of all sections, including Division 01 Sections and Drawings, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.
   1. Related Work Described Elsewhere:
      a. Requirements for testing may be described in various Sections of these specifications; where no testing requirements are described but Harris County decides that testing is required, Harris County may require testing to be performed under current pertinent standards for testing.
   2. Work Not Included:
      a. Selection of Testing Laboratory: Harris County will select a qualified independent testing laboratory.

1.03 QUALITY ASSURANCE

A. This Section outlines only minimum standards and requirements. Refer to the Drawings and other sections of the specifications for additional requirements. Bring all conflicts and discrepancies to the attention of the Architect/Engineer and Owner, and do not start work until such conflicts and discrepancies are clarified and corrected.

B. Qualifications of Testing Laboratory:
   1. The testing laboratory will be qualified to Harris County's approval in accordance with ASTM E-329 "Recommended Practice for Inspection and Testing Agencies for Concrete & Steel Used in Construction".

C. Codes & Standards: Testing, when required, will be in accordance with all pertinent codes and regulations and with selected standards of the ASTM International (American Society for Testing and Materials).

D. Testing of Materials and/or Installed Work: Harris County will assign the testing laboratory and pay for Inspection and Testing directly except as further described in Harris County's General Conditions for Building Construction and Related Work, Section
   1. 5.18. Testing and Retesting may be made at any time during the progress of the work.

1.04 PRODUCT HANDLING

A. Promptly process and distribute all required copies of test reports and related instructions to ensure all necessary retesting and/or replacement of materials with the least possible delay in progress of the Work.

B. Submit test inspection reports, including agency's analysis of results and recommendations where applicable, in duplicate to Architect except as otherwise indicated and submit copies directly to governing authorities where required.

PART 2 - PRODUCTS

2.01 PAYMENT FOR TESTING SERVICES

A. Payment shall be in accordance with Harris County's General Conditions for Building Construction and Related Work, Section 5.18.

B. Proof of payment of all the retesting (failures) that are required to be paid for by the Contractor in accordance with Harris County's General Conditions for Building Construction and Related Work, Section 5.18 shall be furnished to Harris County prior to the signing or processing of the final pay estimate.

2.02 CODE COMPLIANCE TESTING

A. Inspections and tests required by codes or ordinances, or by a plan approval authority, and made by a legally constituted authority, shall be the responsibility of and shall be paid for by Harris County, unless otherwise provided in the Contract Documents.

2.03 CONTRACTOR'S CONVENIENCE TESTING

A. Inspection or testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.

PART 3 - EXECUTION

3.01 COOPERATION WITH TESTING LABORATORY

A. Representatives of the testing laboratory shall have access to the Work at all times; the Contractor shall provide access to facilities and stockpiles, at all times in order that the laboratory may properly perform its functions.

3.02 SCHEDULE FOR TESTING

A. Establishing Schedule:
   1. By advance discussion with the testing laboratory selected by Harris County, determine the time required for the laboratory to perform its tests and to issue each of its findings.
   2. Provide all required time within the construction schedule.

B. Revising Schedule: When changes of construction schedule are necessary during construction, coordinate all such changes of schedule with the testing laboratory as required.

C. Adherence to Schedule: When the testing laboratory is ready to test according to the determined schedule, but is prevented from testing or taking specimens due to incompleteness of the work, all extra costs for testing attributable to the delay will be borne by the Contractor.

3.03 TESTING TAKING SPECIMENS

A. All specimens and samples for testing, unless otherwise provided in these Contract Documents, will be taken by the testing laboratory; all sampling equipment and personnel will be provided by the testing laboratory; and all deliveries of specimens and samples to the testing laboratory will be performed by the testing laboratory.

END OF SECTION

SECTION 01 42 00
REFERENCES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. Unless otherwise indicated, the following definitions apply to this project:
   1. “Approved”: The term “approved,” when used to convey Architect's action on Contractor's submittals, applications, and requests, is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
   2. “Directed”: Terms such as “directed,” “requested,” “authorized,” “selected,” “approved,” “required,” and “permitted” mean directed by Architect, requested by Architect, and similar phrases.
   3. “Indicated”: The term “indicated” refers to graphic representations, notes, or schedules on Drawings or to other paragraphs or schedules in Specifications and similar requirements in the Contract Documents. Terms such as “shown,” “noted,” “scheduled,” and “specified” are used to help the user locate the reference.
   4. “Regulations”: The term “regulations” includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
   5. “Furnish”: The term “furnish” means to supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
   6. “Install”: The term “install” describes operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
   7. “Provide”: The term “provide” means to furnish and install, complete and ready for the intended use.
   8. “Installer”: An installer is the Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
   9. The term “experienced,” when used with an entity, means having successfully completed a minimum of 3 previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
      a. Using a term such as “carpentry” does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as “carpenter.” It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.

1.03 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.

C. Conflicting Requirements:

1. If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.
2. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

D. Copies of Standards:
1. Each entity engaged in construction on Project must be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
2. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source and make them available on request.

E. Abbreviations and Acronyms: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the name of entities generally recognized in the construction industry. The Architect will make a complete list available by the to the Contractor upon written request. Types of entities include:
1. Industry Organizations.
2. Code Agencies.
3. Federal Government Agencies.
4. State Government Agencies.

PART 2 - PRODUCTS

2.01 NOT USED PART 3 - EXECUTION

A. Not Used

END OF SECTION

SECTION 01 45 23

TESTING AND INSPECTING SERVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Requirements and qualifications including but not limited to:
   1. Professional testing and laboratory services.
   2. Accessories necessary for the completion of testing and laboratory services.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
   1. Specific quality assurance and quality control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
   2. Specified tests, inspections, and related actions do not limit Contractor's other quality assurance and quality control procedures that facilitate compliance with Contract Document requirements.
   3. Requirements for Contractor to provide quality assurance and quality control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions.
   4. Specific test and inspection requirements are not specified in this Section.

C. A qualified independent testing laboratory and/or geotechnical engineering service selected and paid by Owner.
   1. The Owner will pay for the initial laboratory services of materials that comply with the requirements of the Contract Documents. The Contractor shall pay for testing and retesting of materials that do not comply with the requirements of the Contract Documents.

D. Inspecting agency shall perform inspections and tests in accordance with the rules and regulations of the building code, local authorities, Specifications of ASTM, and the Contract Documents.

E. Materials and workmanship found not in compliance with required standards or performance obligations shall be removed and replaced. Replacement and subsequent testing shall be at Contractor’s expense.

F. Where terms “Inspector” and “Laboratory” are used, it is meant and in reference to an officially designated and accredited inspector of the testing laboratory or geotechnical service engaged by Owner.

G. Laboratory inspections shall not relieve the Contractor or Fabricator of his responsibility to furnish materials and workmanship in accordance with the Contract Documents.

H. Contractor or Fabricator shall cooperate with the testing laboratory in matters pertaining to the Work.

I. Contractor to address deficiency and failed reports.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, documented according to ASTM E 329 and ASTM E534; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
   1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
   2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
   3. Testing agencies shall be insured against errors and omissions by a professional liability insurance policy having a minimum limit of liability of $500,000.00.

B. Inspection and testing services the of testing agency shall be under the direction of a Registered Engineer licensed in the State of Texas, charged with engineering managerial responsibility, and having a minimum of five (5) years engineering experience in inspection and testing of construction materials.

C. Concrete Inspectors: Inspecting personnel monitoring concrete Work shall be ACI certified inspectors.

D. Structural Steel: Primary inspectors performing structural steel inspection shall be currently certified AWS Certified Welding Inspectors (CWI), in accordance with the provisions of AWS QCI, *Standard and Guide for Qualification and Certification of Welding Inspectors*.
   1. Inspector may be supported by assistant inspectors who perform specific inspection functions under the direct supervision of the Primary Inspector. Assistant inspectors shall be currently certified AWS Certified Associate Welding Inspectors (CAWI). Work of assistant inspectors shall be monitored daily by the inspector.

E. Testing Equipment: Equipment shall be calibrated at intervals not exceeding 12 months by devices of accuracy traceable to the National Bureau of Standards.

F. Referenced Standards: Latest adopted edition of standards referenced apply to the Work. In the event of conflict between the Contract Documents and referenced standards, the Contract Documents shall govern. In case of conflict between Contract Documents and the Building Code, the more stringent shall govern.

1.4 QUALITY CONTROL

A. Owner Responsibilities: Where quality control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform the services.
   1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
   2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality control activities required to verify that the Work complies with requirements, whether specified or not.
   1. Refer to the individual specification sections for specific requirements.
   2. Unless otherwise indicated, provide quality control services specified and those required by authorities having jurisdiction. Perform quality control services required of Contractor by authorities having jurisdiction, whether specified or not.
   3. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform the quality control services. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
   4. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
   5. Where quality control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality control service.
   6. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
   7. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
   8. Associated Responsibilities and Services: Cooperate with agencies performing required tests, inspections, and similar quality control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
      a. Provide access to the Work.
      b. Deliver of samples to testing laboratory, without cost to Owner, in adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
      c. Advise laboratory and Architect sufficiently in advance of construction operations to allow laboratory to complete required inspections or tests and to assign personnel for field inspection and testing as specified.
      d. Provide facilities for storage and curing of concrete test samples on site for the first 24 hours and for subsequent field curing required by ASTM C31.
      e. Incidental labor, facilities, and equipment necessary to assist laboratory personnel in obtaining and handling samples at the site.
      f. Preliminary design mix proposed for use for material mixes that require control by testing agency.
      g. Provide concrete mix designs in accordance with ACI 301 Section 3.9 made by an independent testing laboratory or qualified concrete supplier. Where mix designs by an independent testing laboratory are required, select and pay for laboratory.
      h. Obtain required inspections or approvals of the building official. Inspection requests and notifications required by building code are responsibility of the Contractor.
      i. Provide current welder certificates for each welder employed.
      j. Provide fabrication and erection inspection and testing of welds in accordance with AWS D1.1, Chapter 6.
         1) Use prequalification of welding procedures in executing the Work.
      k. Security and protection for samples and for testing and inspecting equipment at Project site.

   9. Retesting/Reinspecting: Regardless of payment responsibility of the original tests or inspections, provide quality control services, including retesting and reinspecting, for construction that replaced Work failing to comply with the Contract Documents or Code requirements.

C. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
   1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
   2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
   3. Conduct and interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from requirements.
   4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
   5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
   6. Do not perform any duties of Contractor.

D. Coordination: Coordinate sequence of activities to accommodate required quality assurance and quality control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.5 AUTHORITY AND DUTIES OF LABORATORY PERSONNEL

A. A representative of the testing laboratory, who has reviewed and is familiar with the project and specifications, shall participate in preconstruction conferences. The representative shall coordinate material testing and inspection requirements with the Contractor and its subcontractors consistent with the planned construction schedule. The laboratory representative shall attend conferences required or requested to address quality control issues.

B. Laboratory personnel shall inspect and test materials, assemblies, specimens, and Work performed, including design mixes, methods and techniques and report the progress to the Architect.

C. If material or Work fails to meet requirements of Contract Documents, laboratory inspector shall notify the Construction Manager, Architect, Engineers, supplier or subcontractor providing or preparing the materials or Work being tested of such failure.

D. Laboratory personnel shall not perform the Work of the Contractor or act as foremen or superintendents. Work will be inspected as it progresses, but failure to detect defective Work or materials shall not prevent later rejection when a defect is discovered.

E. Laboratory personnel are not authorized to revoke, alter, relax, enlarge, or release the requirements of the Contract Documents or approve or accept portions of Work, except where approval is specifically specified in the Specifications.

F. Comply with building code requirements for Special Inspections.

1.6 SUBMITTALS

A. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

B. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
   1. Specification Section number and title.

2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality control service.

C. Test and Inspection Reports: Prepare and submit certified written reports specified. Include the following:
1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

D. Submit copies of reports of each inspection and test:
1. Owner, Program or Project Manager, Architect, and each Engineer or outside consultants regarding their particular phase of the project: One copy each.
2. Construction Manager and Contractor: Two copies each.

E. In addition to furnishing a written report, notify Construction Manager and Contractor verbally of uncorrected conditions or failures to comply with requirements of the Contract Documents, and immediately fax and email corresponding report to the Architect and Engineer.

F. At completion of each trade or branch of Work requiring inspecting and testing, submit a final certificate attesting to satisfactory completion of Work and full compliance with requirements of Contract Documents.

G. Submit copies of test results sealed by a Registered Engineer to municipal authorities having jurisdiction, as required.

1.7 TESTING LABORATORY GUIDELINES AND PROCEDURES

A. Technicians scheduled to perform specific testing services must be qualified to review and perform other services that overlap, i.e. earthwork, foundation inspections, rebar inspection, and concrete when scheduled concurrently at the site.

B. Technician time for services performed will be reimbursed at a regular time rate. Compensation at the overtime rate will be considered for hours over eight hours spent at the site on a single day, field testing services performed on a Saturday or Sunday, and field services performed on a recognized holiday.

C. There shall be a three hour minimum for each scheduled testing service. Vehicle charges will be included on a $25.00 per trip basis.

D. Cylinder pick up will be controlled by the technician performing test on a scheduled pick up day. If there are no testing services scheduled, the cylinder pick up fee is $40.00 on week days and $50.00 on weekends and holidays with no technician or vehicle charge.

E. The Contractor shall bear the responsibility of scheduling the testing services. The Contractor and the testing laboratory shall assume full responsibility to coordinate the testing services. Cancellations or failed test shall be reimbursable to the Owner by the responsible party for the cancellations or failure of a test or service.

PART 2 - PRODUCTS
Not used.

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.
5. Deficiency log.

B. Maintain log at site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.2 TESTING AND INSPECTION SERVICES

A. Testing services shall include, but not be limited to those specified below or which are necessary or required during course of construction to ascertain specification compliance and which may be deemed necessary by Architect, Engineer, or Owner to ensure the quality of the Work.

B. The Owner reserves the right to add to or delete any or all inspection and testing specified, excluding testing required by the applicable building codes.

C. If conflicts arise between Drawings and Specifications, notify Architect immediately. The most stringent requirements shall dictate procedure.

3.3 TESTING OF EARTHWORK

A. Testing Services (As specified or required):
1. References (As applicable for tests required):
a. American Society for Testing and Materials (ASTM)
1) D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3)
2) D2922, Standard Test Method for Density of Soil and Soil-Aggregate In Place By Nuclear Methods (Shallow Depth)
3) D4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

b. American Association of State Highway and Transportation Officials (AASHTO)
   1) T89, Determining the Liquid Limit of Soils
   2) T90, Determining the Plastic Limit and Plasticity Index of Soils
   3) T99, Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305-mm (12-in) Drop
   4) T238, Density of Soil and Soil Aggregates In Place By Nuclear Methods (Shallow Depth)

2. Perform sieve analysis to develop grain size distribution curves for materials to be used for subgrade, fill under slab on grade, and backfills.
3. Establish the moisture density relation of soils to be used as fill using the method best suited to the type of fill material.
4. Determine moisture content of all fill materials before placement and advise Contractor when it is or is not suitable to achieve required compaction.
5. Determine Liquid Limit in accordance with ASTM D4318 or AASHTO T89, Plastic Limit in accordance with ASTM D4318, and Plasticity Index in accordance with ASTM D4318 of all fill material,
6. Perform one in place density test for each 4,000 square feet (445 square yards) of existing subgrade material.
7. Perform Moisture-Density curve in accordance with ASTM D698 or AASHTO T99 for one type of fill material. If the original choice of material does not meet the specifications, the Contractor shall pay for additional testing.
8. Perform in place density tests of each lift of compacted fill at locations adequate to evaluate the degree of compaction of all fill areas. Conduct one test for each 4,000 square feet (445 square yards) of each lift of compacted fill.
9. Perform testing at a frequency of one in-place density and moisture test for each 75 lineal feet or less of utility trench, with a minimum of three tests per lift

B. Reports: Submit reports with the following information:
   1. Type and condition of soil at footing bottoms.
   2. Level of water table in the excavated areas.
   3. Grain size distribution of fill materials (average of three tests).
   4. Moisture density test results.
   5. In place density test results with moisture content and relative density of each layer of compacted fill. Include with in place density test results, a plan showing location of each test.
   6. Notify Architect by telephone within one hour of the discovery of the following conditions and follow up telephone notification with written report.
      a. Materials used, or degree of soil compaction not meeting specified requirements.
      b. Frost and freeze protection requirements for excavation bottoms not being complied with.
      c. Water in excavations which is not being removed prior to Work being performed in excavation.

3.4 INSPECTION OF PIPED SITE UTILITIES

A. Laboratory representative shall observe and report on the following:
   1. Proper alignment and grade of trenches.
   2. Pipe bedding and supports.
   3. Pipe, joints, jointing material, and thrust blocks prior to installation of pipe.
   4. Installation of pipe and joints.
   5. Testing of piped utilities performed by Contractor.

3.5 PAVING

A. Testing Services: Perform field tests for moisture density properties:
   1. Provide field testing of the subgrade as specified.
   2. Paving Subbase: Provide one field test for every 7,500 square feet of area of crushed limestone or caliche subbase.
   3. Lime Treated Subgrade: Provide one field test for every 7,500 square feet of area of lime treated subgrade for content of lime and subgrade compaction.
   4. Cement Soil Stabilization: Provide one field test for every 7,500 square feet of area of cement stabilized subgrade for content of cement and subgrade compaction.

3.6 PIER DRILLING OPERATION

A. A representative of a qualified geotechnical laboratory shall provide services specified.

B. Laboratory representative shall make continuous inspections to determine that proper bearing stratum is obtained and utilized for bearing and that shafts are properly clean and dry before placing concrete.

C. Laboratory shall furnish complete pier log showing the diameter, top and bottom elevations of each pier, casing required or not required, actual penetration into bearing stratum, elevation of top of bearing stratum, volume of concrete used, and deviations from specified tolerances.

D. Laboratory representative shall make continuous inspections of drilled pier construction to check the following:
   1. Verify soundness of bearing stratum and desired penetration.
   2. Verify pier dimensions and reinforcing used.
   3. Monitor condition of hole and removal of water and loose material from bottom.
   4. Monitor placement of concrete and use of tremie or pumps.
   5. Monitor the extraction of casing, if used.

E. Request probe holes when deemed necessary to confirm safe bearing capacity.

3.7 CONCRETE REINFORCING STEEL AND EMBEDDED METAL ASSEMBLIES

A. Inspect concrete reinforcing steel prior to placing concrete for compliance with Contract Documents and approved shop drawings. Noncompliance with Contract Documents and approved shop drawings shall be immediately brought to the attention of the Contractor for correction and, if left uncorrected, reported to the Architect.

B. Laboratory representative shall observe and report on the following:
   1. Number and size of bars.
   2. Bending and lengths of bars.
   3. Splicing.
   4. Clearance to forms, including chair heights.
   5. Clearance to sides and bottom of trench if soil formed.
   6. Clearance between bars or spacing.
   7. Rust, form oil, and other contamination.
   8. Grade of steel.
   9. Securing, tying, and chairing of bars.
   10. Excessive congestion of reinforcing steel.
   11. Installation of anchor bolts and placement of concrete around such bolts.

12. Fabrication and installation of embedded metal assemblies, including visual inspection of all welds.
13. Visually inspect studs and deformed bar anchors on embedded assemblies for compliance with Contract Documents. Check number, spacing and weld quality. If, after welding, visual inspection reveals that a sound weld or a full 360 degree fillet has not been obtained for a particular stud or bar, such stud or bar shall be struck with a hammer and bent 15 degrees off perpendicular and then bent back into position. Anchors failing this test shall be replaced.

C. Provide a qualified, experienced inspector to inspect reinforcing steel. Inspector shall have a minimum of three years experience inspecting reinforcing steel in projects of similar size.

3.8 CONCRETE INSPECTION AND TESTING

A. Receive and evaluate proposed concrete mix designs submitted by Contractor. If mix designs comply with Drawings and Specifications, the laboratory shall submit a letter to the Architect certifying compliance. Mix designs not complying with Drawings and Specifications shall be returned by the laboratory as being unacceptable. Check the proposed mixes for proportions, water cement ratio and slump in accordance with ACI 613 and 318.

B. Comply with ACI 311 *Guide For Concrete Inspection* and ACI *Manual of Concrete Inspection* (SP-2).

C. Sample and test concrete placed at the site in accordance with ASTM C172. Each sample shall be obtained from a different batch of concrete on a random basis.

D. Test concrete:
1. Mold and cure five specimens from each sample.
   a. For each 50 cubic yards or fraction thereof of structural building concrete; and
   b. For each 100 cubic yards or fraction thereof of nonstructural concrete and site Work paving and sidewalks.
   c. Laboratory cure two cylinders in accordance with ASTM C192.
   d. Field cure remaining cylinders in accordance with ASTM C31.

2. Two specimens shall be tested at seven days for information, two shall be tested at 28 days for acceptance.

E. Deviations from the requirements of ASTM Specifications shall be recorded in the test report. Test concrete specimens in accordance with ASTM C39.

F. Specimens for pumped concrete shall be taken at the discharge end of pumping equipment.

G. Supervise curing and protection provided for test specimens in field, and transportation from the field to laboratory. Test cylinders shall be stored in the field 24 hours and then carefully transported to laboratory and cured in accordance with ASTM C31.

H. Make one strength test (four cylinders) of each mix design of concrete placed in any one day.

I. Make one slump test for each set of cylinders following procedural requirements of ASTM C143 and ASTM C172. Make additional slump tests whenever consistency of concrete appears to vary. Slump tests corresponding to samples from which strength tests are made shall be reported with strength test results. Other slump tests need not be reported.

J. Determine total air content of air entrained normal weight concrete sample for each strength test in accordance with ASTM C231.

K. Determine air content and unit weight of lightweight concrete sample for each strength test in accordance with ASTM C173 and ASTM C567.

L. Determine temperature of concrete sample for each strength test.

M. Inspect each batch of concrete, monitor addition of mixing water to assure uniform consistency from truck to truck. Check mixing form mixers before mix begins to set and within time limits set forth in ASTM C94.
   1. Monitor addition of water and high range water reducer to concrete at job site and length of time concrete is allowed to remain in truck during placement.

N. Testing agency shall furnish and maintain a competent inspector at the mixing plant at the start of each day's mixing. Inspector shall examine concrete materials for compliance with Specifications and approved mix design, weighing and measuring devices, proportioning and mixing of materials, water and cement content of each batch, general operation of the plant, and transportation of concrete to jobsite. Inspector shall verify that amount of free surface moisture contained in fine and course aggregate has been properly accounted for in the concrete mixing to achieve required consistency and water cement ratio.

O. Testing laboratory shall monitor addition of water to concrete at the jobsite and the length of time concrete is allowed to remain in the truck before placement. Inspector shall compare mixture with criteria on the approved mix design and report any significant deviation to the Architect, Contractor and concrete supplier. Do not permit addition of water which will exceed maximum water/cement ratio for the mix as given on the approved mix design.

P. Observe placing of concrete, except nonstructural slabs on grade and site Work. Observe and report on placing method, consolidation, cold joints, length of drop, and displacement of reinforcement. Report deficiencies to Contractor immediately for corrective action. Inspections may be reduced to a periodic basis when all procedures have been deemed satisfactory by the laboratory.

Q. Test reports shall include but no be limited to the following information: date of concrete placement, concrete mix identification number or proportion of ingredients, truck ticket number, time test was made, time of batching, location of each placement, slump, unit weight, water content (microwave test) and air content of concrete sampled and date and results of strength test.

R. Report promptly to Architect all details of reasons for rejection of any and all quantities of concrete. Give all information concerning locations of the concrete pours, quantities, date of pours, and other pertinent facts concerning concrete represented by the specimens.

S. Testing laboratory shall certify each delivery ticket indicating class of concrete delivered (or placed), amount of water added and time at which cement and aggregate were dispensed into the truck, and time at which concrete was discharged from the truck.

T. Evaluation and Acceptance:
   1. If measured slump, or air content of air entrained concrete, falls outside specified limits, a check test shall be made immediately on another portion of the same sample. In the event of a second failure, concrete shall be considered to have failed to meet the requirements of the specifications, and shall not be used in the structure.

2. Strength level of concrete will be considered satisfactory if the averages of sets of three consecutive strength tests results are equal to, or exceed, specified strength and no individual test result (average of two cylinders) is below specified strength by more than 500 psi.
3. Completed concrete Work will be accepted when requirements of ACI 301 Chapter 18 *Specifications for Structural Concrete for Buildings* have been met.

U. Concrete Test Reports: Reports shall be made and distributed immediately after respective tests or inspections are made.
1. Where reports indicate deviations from Contract Documents, they shall also include a determination of the probable cause of deviation and where applicable, a recommendation for corrective action.

V. Furnish a statistical analysis for each class of concrete placed on the project in accordance with ACI 214 and ACI 318. Information shall be updated and distributed once a month as directed by the Architect. Information shall include, but not be limited to, the following:
1. Strength tests at 7 days of one cylinder.
2. Strength tests at 28 days of two cylinder averages.
3. 28 day moving average strength tests of last three test groups.
4. Standard deviation and coefficient of variation based on 28 day strength tests.
5. Average strength and number of 28 days tests for most recent month.

W. Test Footings (Shafts) (Piers) (Caissons): Same diameter and type specified for footings, placed in same manner. Accepted test footings may be used in the Work.

X. Noncompliant Test Reports: Fax test reports indicating noncompliance immediately to each party on the test report distribution list. Copies shall be on different colored paper.

Y. Inspect application of curing compound and monitor curing conditions to assure compliance with specification requirements. Report curing deficiencies to the Contractor immediately and submit a written report to the Architect.

3.9 TESTING OF NONSHRINK GROUT

A. Make one strength test for all plates grouted and for all grout used in joints between members.

B. Each test shall consist of four cubes, two tested at 7 days and two at 28 days, made and tested in accordance with ASTM C109, with the exception that grout shall be restrained from expansion by a top plate.

3.10 STRUCTURAL STEEL

A. Inspect structural steel during and after erection for compliance with Contract Documents and shop drawings. Review and report on fabricator's quality control procedures and capabilities.

B. Field Inspection:
1. Proper erection of pieces.
2. Proper touch up painting of shop primed structural steel exposed to view or in crawl space.
3. Proper installation of bolts.
4. Plumbness of structure and proper bracing.
5. Proper field painting.
6. Initial inspection of welding process and periodically thereafter as necessary.

7. Visual examination of completed welds.
8. Ultrasonic testing of penetration field welds.
9. Installation of field welded shear studs.
10. Inspect shop fabricated members, upon arrival at the site, for defects incurred during transit and handling.
11. Measure and record camber of beams upon arrival and before erection for compliance with specified camber. Measure lying flat with web horizontal. Return members outside specified camber tolerance to shop for correction.

C. Qualifications of Welders: Fabricator and erector shall provide the testing laboratory with names of welders employed on Work, along with certification that each welder has passed qualification tests within the past 12 months, using procedures covered in AWS D1.1 *Structural Welding Code - Steel*. Verify welder qualifications.

D. Inspection of field welding shall include:
1. Visually inspect fillet welds for size, soundness, and proper return around ends. Inspect seams, folds, and delaminations.
2. Visually inspect welds for proper repair of painting.
3. Ultrasonically test penetration welds in accordance with ASTM E164.
4. Inspect surfaces to be welded. Note surface preparations, fit up, and cleanliness of surface. Verify electrodes for size, type, and condition.
5. Welding inspector shall be present during alignment and fit up of members being welded, and shall verify for correct surface preparation of root openings, sound weld metal, and proper penetration in the root pass. Where weld has not penetrated completely, inspector shall order the joint to be chipped down to sound metal, or gouged out, and rewelded. Thoroughly inspect root passes for cracks. Gouge out cracks and rewelded to 2 inches beyond each end of crack.
6. Inspector shall verify that welds have been marked with welder's symbol and shall mark welds requiring repairs and reinspection. Inspector shall maintain a written record of welds. Work completed and inspected shall receive an identification mark by the inspector. Identify unacceptable material and Work identified by word *reject* or *repair* marked directly on the material.
7. Testing agency shall advise the Owner and Architect of any shop and/or field conditions which may require further tests and examination by means other than those specified. Additional tests and examinations shall be performed as authorized by the Owner and Architect.
8. Owner reserves the right to use ultrasonic or radiographic inspection to verify adequacy of welds. Testing procedures and acceptance criteria shall be as specified in AWS D1.1.
9. Weld quality to comply with the American Institute of Steel Construction (AISC) Manual of Steel Construction.
10. Determine percentage of weld tested by the number of welds that fail the initial testing.
11. Reweld and retest welds that fail until the welds pass. Test two additional welds for every weld failure.

E. Inspect bolted construction in accordance with AISC *Specification for Structural Steel Buildings*:
1. Visually inspect bolts ensuring that plies have been brought into snug contact.
2. Inspect high strength bolt in accordance with Section 9 of the *Specifications for Structural Joints Using ASTM A325 or A490 Bolts*.

F. Inspect stud welding in accordance with Section 7.8, of AWS D1.1 *Structural Welding Code*:
1. Weld at least two shear studs at the start of each production period to determine correct generator, control unit, and stud welder setting. The studs shall be capable of being bent 45 degrees from vertical without weld failure.

2. When the temperature is below 32 degrees F (0 degrees C), test one stud in each 100 after cooling. Do not weld studs at temperatures below 0 degrees F or when surface is wet with rain or snow. If stud fails in the weld, two new studs shall pass the test before resumption of welding.
3. Visually inspect studs for compliance with the requirements of the Contract Documents. Verify number, spacing, and weld quality. If, after welding, visual inspection reveals that a sound weld or a full 360 degree fillet has not been obtained for a particular stud, that stud shall be struck with a hammer and bent 15 degrees off perpendicular in the direction away from the missing weld. Studs failing test shall be replaced.

3.11 REINFORCING STEEL MECHANICAL SPLICES

A. Inspection and Observation Services:
1. Visually inspect and report on completed condition of each mechanical splice of reinforcing steel.
2. Visually inspect each mechanical splice to ensure compliance with the ICC-ES Reports and the manufacturer's published criteria for acceptable completed splices.
3. Place special emphasis on the inspection of the end preparation of each bar to be spliced required by the ICC-ES Report.

B. Reports: Submit reports to Architect:
1. Submit copies of manufacturer's published criteria for acceptable completed splices prior to observing mechanical splices.
2. Reports on each mechanical splice shall indicate location of the splice, size of bars spliced, and acceptability or rejection of splice. Indicate reasons for rejection on each report.

3.12 OPEN WEB JOISTS AND JOIST GIRDERS

A. Inspect joists at jobsite for compliance with specified fabrication requirements. Verify welded connections between web and chord, splices, and straightness of members.

B. Inspect installation of joists at jobsite. Check connections to supporting members, chord extensions, number of rows of bridging, and bridging connections for compliance with Contract Documents and referenced standards.

C. Verify welder qualification certificates for both shop and field welding operators.

3.13 METAL FLOOR DECK

A. Field inspection shall consist of:
1. Verifying types, gauges and finishes for compliance with Contract Documents and shop drawings.
2. Examine composite floor deck exposed to crawl space for damage to galvanizing due to welding or construction activities. Repair galvanized composite floor deck in accordance with the specifications.
3. Examine the erection of metal deck, fastenings, reinforcing of holes, deck reinforcing, miscellaneous deck supports, hanger tabs, shear studs, deck closures, painting or other coating.
4. Certification of welders.
5. Inspect and test field welded shear studs used to fasten metal floor decking to supporting steel as specified for structural steel.

3.14 METAL ROOF DECK

A. Field inspection shall consist of:
   1. Verify types, gauges and finishes for compliance with Contract Documents and shop drawings.
   2. Examine the erection of the metal deck, including fastenings at supports and side laps, reinforcing of holes, and miscellaneous deck supports.
   3. Certification of welders.
   4. Visual inspection of at least 25 percent of welds.

3.15 SPRAYED FIREPROOFING

A. Verify applied thickness, density, and bond strength of sprayed fireproofing meets fire rating requirements of approved design.

B. Verify installation complies with fire rating requirements of approved design.

C. Inspect and test for thickness:
   1. Test 25 percent of structural frame columns and beams in each building level.
   2. Test 10 percent of beams other than structural frame in each building level.
   3. Test one slab per 5,000 square feet of building area.

D. Inspect and test in accordance procedures of ASTM E605 and ASTM E736.

3.16 EXPANSION BOLT INSTALLATION

A. Inspect drilling of each hole and installation of each expansion bolt for compliance with Contract Documents and shop drawings.

B. Verify installation torque for each expansion bolt for compliance with manufacturer's installation instructions.

3.17 LIGHTWEIGHT INSULATING CONCRETE FILL

A. Inspection and Observation Services (As required):
   1. Inspection of roof deck prior to start of Work.
   2. Inspection during installation of insulation and lightweight insulating concrete fill Work to ascertain compliance with Contract Documents.
   3. Observation of base ply fastener pull tests performed by Contractor to ascertain minimum withdrawal resistance of 40 pounds per fastener.

B. Testing Services (As required):
   1. References (As applicable for tests required):
      a. American Society for Testing and Materials (ASTM)
         1) C177, Standard Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties By Means of the Guarded Hot Plate Apparatus
         2) C495, Test Method for Compressive Strength of Lightweight Insulating Concrete
         3) C578, Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   2. Test EPS insulation board for thermal insulation value in accordance with ASTM C177.
   3. Test lightweight insulating concrete fill in accordance with ASTM C495 for:

a. Mix design compressive strength.
b. Mix design wet and dry density range.
c. Number of Tests:
    1) One per 5,000 square feet.
    2) Not less than one for each day's Work.

4. Test EPS insulation board for density in accordance with ASTM C578.

3.18 TESTING OF ROOFING

A. Inspection and Observation Services (As required):
1. Inspection of roof deck prior to start of Work.
2. Inspect on site condition of stored roofing materials.
3. Inspection during roofing, roof insulation, and sheet metal Work to ascertain compliance with Contract Documents.
4. Observation of roof test cuts performed by Contractor to ascertain that they are properly made.
5. Observation of patching of roof test cuts to ascertain that they are properly made.

B. Testing Services (As required):
1. Perform dissection and analysis on cuts provided by Contractor to confirm number of plies, bonding of plies, weight of bitumen and softening temperature to ascertain compliance with specifications.

3.19 MASONRY

A. Inspection and Observation Services:
1. Inspection of placement of reinforcement including condition, grade, size, location, spacing, and lap splices.
2. Review mortar design mixes.
3. Inspection of laying, mortaring, and grouting of concrete masonry units and elements.

B. Testing Services:
1. References (As applicable for tests required):
    a. ASTM International (ASTM)
        1) C140, Standard Test Methods of Sampling and Testing Concrete Masonry Units
        2) C780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
        3) C1019, Standard Test Method for Sampling and Testing Grout
        4) E447-97, Standard Test Methods for Compressive Strength of Laboratory Constructed Masonry Prisms.

2. Testing of Concrete Masonry Units (CMU):
    a. Preconstruction: Perform the following tests in accordance with ASTM C140.
        1) Compressive Strength
        2) Absorption
        3) Weight
        4) Moisture Content
        5) Dimensions.

3. Mortar Tests:

a. Preconstruction: Perform the following tests in accordance with ASTM C780 on each type of mortar mix used on the Project.
b. 28 Day Compressive Strength
c. Water Retention
d. Construction: Perform 28 day compressive strength test in accordance with ASTM C780 on each type of mortar mix used on the Project at the rate of one test per 2,000 square feet of masonry.

4. Refer to and include Work for reinforcing steel specified.
5. Grout Tests:
   a. Preconstruction: Perform the following tests in accordance with ASTM C1019 on each type of grout mix used on the Project.
      1) 28 Day Compressive Strength
      2) Construction: Perform 28 day compressive strength test in accordance with ASTM C1019 on each type of grout mix used on the Project at the rate of one (1) test per 2,000 square feet of masonry.
      3) Prism Test: Perform preconstruction 28 day compressive strength test on concrete masonry walls in accordance with ASTM E447-97, Method B.

3.20 REPAIR AND PROTECTION

A. On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
   1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 30.

B. Protect construction exposed by or for quality control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality control services.

END OF SECTION 01 45 20

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes temporary facilities and controls required for this Work include, but are not necessarily limited to:
   1. Temporary utilities such as gas, water, electricity, and telephone;
   2. Field offices, sanitary facilities, enclosures, barricades as required by Sections 4.04, 4.05, and 4.11 of Harris County's General Conditions for Building Construction and Related Work.

B. Related Sections: Work of all sections, including Division 01 Sections and Drawings, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.
   1. Related Work Described Elsewhere:
      a. Compliance with Safety Regulations: Compliance with all requirements of pertinent codes, regulations, and ordinances.
      b. Subcontractor Equipment: Except that equipment furnished by subcontractors shall comply with all requirements of pertinent safety regulations, the ladders, hoists, planks, and similar items normally furnished by individual trades in execution of their own portions of the work are not part of this section of these specifications.
      c. Utility Hook-Up: Installation and hook-up of the various utility lines are described in the pertinent other sections of these specifications.

1.03 PRODUCT HANDLING

A. Use all means necessary to maintain temporary facilities and controls in proper and safe condition throughout progress of the work.

B. Replacements: In the event of loss or damage, immediately make all repairs necessary, to the approval of the Architect and at no additional cost to Harris County.

PART 2 - PRODUCTS

2.01 UTILITIES

A. Temporary Utilities:
   1. General: Provide and pay all costs for all gas, water, and electricity required for the performance of the work, when permanent utilities are not available.
   2. Temporary Gas & Water: Furnish and install all necessary temporary piping and, upon completion of the work, remove all such temporary piping.
   3. Temporary Electricity: Furnish and install all necessary temporary wiring.
      a. Furnish and install area distribution boxes so located that the individual trades may use their own construction-type extension cords to obtain adequate power and artificial lighting at all points where required by inspectors and for safety.

B. Telephone: If a job office is required, maintain a telephone for the use of the Architect. If a job office is not required, Contractor must remain accessible to the Architect by means of a temporary telephone, a mobile phone, or telephone paging system.

2.02 INSURANCE

A. The Contractor shall be held completely responsible for all insurance coverage in accordance with Section 3.02 of the Harris County General Conditions for Building Construction and Related Work.

2.03 STATE AND LOCAL TAX

A. State and Local tax shall come under the control as indicated in the "Sales Tax Exemption Notice to Contractors".

2.04 DRINKING WATER

A. The General Contractor shall provide drinking water, which shall be cooled in warm weather, for all workmen and job personnel. He shall provide containers of water and paper cups at convenient locations where work is being executed as well as containers and cups inside the several offices at the job.

2.05 TEMPORARY HEAT

A. The Contractor shall provide temporary heat, as required by weather conditions and work requirements, in order to insure timely and proper performance of work under the contract. Contractor shall pay all costs for equipment, fuel and operation of heating equipment.

B. Heating equipment shall be such that it will in no way damage the work and shall be operated in a safe manner.

C. Temporary Gas: The contractor shall make his own arrangements for any gas that may be required.

2.06 TEMPORARY LADDERS, SCAFFOLDS, HOISTS, ETC.

A. The Contractor shall furnish and maintain all equipment such as temporary ladders, ramps, scaffolds, hoists, runways, derricks, chutes, etc., as required for the proper execution of the work.

B. All such apparatus, equipment and construction shall meet all requirements of the Labor Law and other State or Local Laws applicable thereto.

C. The Contractor shall provide, install, maintain and remove at completion of work all interior and exterior scaffolding required for the execution of masonry work. Erect scaffolding on the side of the wall on which facing work occurs. No scaffolding shall be built into any face work.

D. Scaffolding for all other work shall be provided, installed, maintained and removed at completion of work by the trade requiring such scaffolding.

E. Trades whose work is to be built into masonry shall be allowed the use of scaffolding that is provided for masonry work.

2.07 PUMPING, SHORING & TEMPORARY COVERINGS

A. When necessary to avoid delay or to protect work on the premises, provide suitable pumping equipment and keep excavation, pits and other areas involved free of water that may leak, seep, or rain in.

B. Provide and be responsible for all temporary shoring required for executing new work and protecting new and existing work.

C. When necessary to avoid delay or to protect work, provide suitable watertight coverings over windows, doors, hatchways, roofs and other such openings vulnerable to weather.

2.08 PROJECT CLOSE-DOWN

A. In the event of work suspension or project close-down, the Contractor will be responsible for security and protection of all portions of the project, stored materials, construction and equipment.

PART 3 - EXECUTION

3.01 REMOVAL

A. Maintain all temporary facilities and controls as long as needed for the safe and proper completion of the work; remove all such temporary facilities and controls as rapidly as progress of the work will permit or as directed by the Architect.

END OF SECTION

SECTION 01 53 80
PROJECT SIGN

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section is for Contractor to provide two (2) painted single face project sign as specified herein and as per Drawing.
   1. It shall be the responsibility of the General Contractor to arrange for and absorb all costs for the project sign.

B. No other signs shall be permitted on the site, unless approved by the Architect.

C. Related Sections: Work of all sections, including Division 01 Sections and Drawings, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures".

B. Submit sign layout and colors to the Architect for approval prior to fabrication.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Sign: Shall be 4 feet-0 inch x 8 feet-0 inch, 3/4 inch thick exterior grade plywood. Plywood to be Southern Yellow Pine AC Grade.

B. Posts: 4 inch x 4 inch x 12 feet-0 inch long treated wood.

C. Bracing: Of size and type recommended by Contractor to suit application and enable sign to withstand 50 mph gale winds.

D. Fasteners: Four (4) 4-1/2 inch long galvanized bolts with nuts per post in locations indicated on Drawings.

E. Paint:
   1. Waterproof enamel white paint for Contractor to paint the front, back and sides of the sign prior to painting any graphics.
   2. Navy blue waterproof enamel paint for letters.
   3. Carmine red waterproof enamel paint for border at perimeter of sign.

F. Bank Sand: Of type recommended by Contractor to suit application.

G. Other Materials: Provide other materials, not specifically described, but required for a complete and proper installation.

PART 3 - EXECUTION

3.01 LOCATION

A. Locate sign as directed by the Architect.

3.02 TEMPORARY PROJECT SIGN FABRICATION

A. Provide two (2) single faced painted framed 3/4 inch thick exterior grade Southern Yellow Pine AC Grade plywood project sign mounted on 4 inch x 4 inch treated posts as per Drawing.

B. Fabrication and painting shall be done by an approved sign painting shop using experienced, professional sign painters.

C. The Contractor shall paint the front, back and sides of the sign with two (2) coats of waterproof enamel white paint before any graphics are painted on sign. Paint per Division 09 Section "Painting".

D. The sign shall include, but not be limited to, the information shown on the Drawings. Contractor to fill in the information which is shown on Drawings. Prior to fabrication, submit sign layout and colors to the Architect for approval.
   1. All letters one (1) inch or less in height to be Helvetica bold style.
   2. All letters larger than one (1) inch in height to be Helvetica extra bold condensed.
   3. All letters to be navy blue with white background.
   4. Carmine red 2-1/2 inch border at perimeter of sign.

3.03 INSTALLATION

A. Install 4 inch x 4 inch x 12 feet-0 inch posts set in compacted bank sand fill as dimensioned on Drawings.

B. Install sign on posts with four (4) 4-1/2 inch long galvanized bolts with nuts per post in locations shown on Drawings.

C. Contractor to be responsible for the required bracing of sign. Sign must be capable of withstanding 50 mph gale winds.

3.04 SIGN REMOVAL

A. The sign shall be removed by Contractor at job's end and shall become the property of Harris County.

B. Fill in holes where posts are removed to match adjacent compacted soil.

END OF SECTION

SECTION 01 55 50
TRAFFFIC CONTROL AND REGULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes requirements for signs, signals, control devices, traffic barriers, flares, lights and traffic signals; construction parking control, designated haul routes, and bridging of trenches and excavations.

B. Qualifications and requirements for use of flagmen.

C. Related Sections: Work of all sections, including Division 01 Sections and Drawings, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 REFERENCES

A. Texas Manual on Uniform Traffic Control Devices (TMUTCD)

B. Article 4413 (29bb), commonly referred to as Private Investigators and Private Security Agencies Act, and Article 2.12, Texas Code of Criminal Procedure.

C. Code of Ordinances, City of Houston, Texas.

1.04 SUBMITTALS

A. Submit under provisions of Division 01 Section "Substitutions".

B. Traffic control plan:
   1. If using traffic control plan contained in the Contract without modification, submit a letter confirming use of the plan.
   2. If using a different traffic control plan, submit the plan for approval. The plan must conform to TMUTCD requirements and be sealed by a Registered Texas Professional Engineer.

C. Submit copies of approved lane closure permits issued by City Traffic Engineering Branch.

D. Submit Schedules of Values for traffic control plan and flagmen within 30 days following Notice to Proceed.

E. Submit records verifying qualifications of Uniformed Peace Officers and Certified Flagmen proposed for use on the Work.

F. When working in the central business district, submit copies of approved Pedestrian Way permits issued by the City’s Traffic Engineering Branch.

1.05 FLAGMEN

A. Use Uniformed Peace Officers and Certified Flagmen to control movement of vehicular and pedestrian traffic when construction operations encroach on public traffic lanes.

B. Uniformed Peace Officer: Individual employed full-time as a peace officer who receives separate compensation as a privately employed flagmen. Private employment may be an employee-employer relationship or on an individual basis. Flagman my not be in the employ of another peace officer nor be a reserve peace officer.
   1. Uniformed Peace Officers may be:
      a. sheriffs and their deputies;
      b. constables and deputy constables;
      c. marshals or police officers of an incorporated city, town or village; or
      d. as otherwise provided by Article 2.12, Code of Criminal Procedures.

2. The Uniformed Peace Officer must be a full-time peace officer, must work a minimum average of 32 paid hours per week, and must be paid a rate not less than the prevailing minimum hourly wage rate set by the federal Wage and Hour Act. The individual must be entitled to vacation, holidays, and insurance and retirement benefits.

C. Certified Flagman: Individual who receives compensation as a flagman and meets the following qualifications:
1. Formally trained and certified in traffic control procedures by the City's E.B. Cape Center.
2. Speaks English. Ability to speak Spanish is desirable, but not required.
3. Paid for flagman duty at an hourly rate not less than the wage rate set for Rough Carpenter under the Harris County's Wage Scale for Engineering Construction.

D. Certified Flagmen must wear a distinctive uniform, bright-colored vest, and be equipped with appropriate flagging and communication devices while at the Work sit. They must also have in the possession while on duty, a proof of training identification card issued by the appropriate training institute.

PART 2 - PRODUCTS

2.01 SIGNS, SIGNALS, AND DEVICES

A. Comply with TMUTCD requirements.

B. Traffic cones and drums, flares and lights: Conform to local jurisdictions' requirements.

C. When working in the Central business district, provide pedestrian pathway signage approved by the City of Houston Traffic Management Branch.

2.02 PORTABLE LOW PROFILE CONCRETE BARRIERS

A. The low profile concrete barrier is a patented design. Information concerning this barrier may be obtained from Texas Transportation Institute. Texas A&M University System, College Station, Texas 77843-3135, (409) 845-1712.

PART 3 - EXECUTION

3.01 PUBLIC ROADS

A. Submit request forms for lane closure and sidewalk closure to the City of Houston Traffic Management Branch at least three (3) working days prior to need for blocking vehicular lanes or sidewalks. Do not block lanes or sidewalks without approved permits. Obtain application from the City of Houston Traffic Management Branch at 901 Bagby, Houston, Texas 77002 or (712) 837-0311.

B. Follow laws and regulations of governing jurisdictions when using public roads. Pay for and obtain permits from jurisdiction before impeding traffic or closing lanes. Coordinate activities with Project Manager.

C. Give Project Manager one-week notice before implementing approved traffic control phases. Inform local businesses of impending traffic control activities.

D. Notify police department, fire department, METRO, and local schools, churches, and businesses in writing a minimum of five business days prior to beginning work.

E. Maintain 10-foot –wide all-weather lanes adjacent to the Work for emergency vehicle use. Keep all-weather lanes free of construction equipment and debris.

F. Do not to obstruct normal flow of traffic from 7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m. on designated major arterials or as directed by Project Manager.

G. Maintain local driveway access to residential and commercial properties adjacent to work areas at all times. Use all-weather materials approved by Project Manager to maintain temporary driveway access to commercial and residential driveways.

H. Keep streets entering and leaving job site free of excavated material, debris, and foreign material resulting from construction operations in compliance with applicable ordinances.

I. Remove existing signage and striping that conflict with construction activities or that may cause driver confusion.

J. Provide safe access for pedestrians along major cross streets.

K. Alternate closures of cross streets so that two adjacent cross streets are not closed simultaneously.

L. Do not close more than two (2) consecutive esplanade openings at a time without prior approval from Project Manager.

3.02 CONSTRUCTION PARKING CONTROL

A. Control vehicular parking to prevent interference with public traffic and parking, access by emergency vehicles, and the City's and Owner's operations.

B. Monitor parking of construction personnel's vehicles in existing facilities. Maintain vehicular access to and through parking areas.

C. Prevent parking on or adjacent to access roads or in non-designated areas.

3.03 FLARES AND LIGHTS

A. Provide flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.

3.04 HAUL ROUTES

A. Utilize haul routes designated by authorities or shown on Drawings for construction traffic.

B. Confine construction traffic to designated haul routes.

C. Provide traffic control at critical areas of haul routes to regulate traffic and minimize interference with public traffic.

3.05 TRAFFIC SIGNS AND SIGNALS

A. Construct necessary traffic control devices for temporary signals required to complete the Work including loop detectors, traffic signal conduits, traffic signal wiring and crosswalk signals. Notify the City of Houston Traffic Management Branch a minimum of 60 days in advance of need for control boxes and switchgear. The City will perform necessary service, programming or adjustments, to signal boxes and switchgear if required during construction.

B. Install and operate traffic control signals to direct and maintain orderly traffic flow in areas under Contractor's control affected by Contractor's operations. Post notices, signs and traffic controls before moving into next phase of traffic control.

C. Relocate traffic signs and signals as the Work progresses to maintain effective traffic control.

D. Unless otherwise approved by Project Manager, provide driveway signs with name of business that can be accessed from each crossover. Use two (2) signs for each crossover.

E. Replace existing traffic control devices in Project area.

F. Project Manager may direct Contractor to make minor adjustments to traffic control signage to eliminate driver confusion and maintain orderly traffic flow during construction at no additional cost to the Owner.

3.06 BRIDGING TRENCHES AND EXCAVTIONS

A. When necessary, construct bridges over trenches and excavation to permit an unobstructed flow of traffic across construction areas and major drives.
   1. Use steel plates of sufficient thickness to support H-20 loading and install to operate within minimum noise.

B. Shore trench or excavation to support bridge and traffic.

C. Secure bridging against displacement with adjustable cleats, angles, bolts or other devices when:

1. bridging is placed over existing bus routes,
2. more than five (5) percent of daily traffic is comprised of commercial or truck traffic.
3. more than two (2) separate plates are used for bridging, and
4. when bridge is to be used for more than five (5) consecutive days.

D. Extend steel plates used for bridging a minimum of 1 foot beyond edges of trench or excavation. Use temporary paving materials such as premix to feather edges of plates to minimize wheel impact on secured bridging.

3.07 REMOVAL

A. Remove equipment and devices when no longer required.

B. Repair damage caused by installation.

C. Remove post settings to a depth of two (2) feet.

3.08 TRAFFIC CONTROL, REGULATION AND DIRECTION

A. Use Flagmen to control, regulate and direct an even flow and movement of vehicular and pedestrian traffic, for periods of time as may be required to provide for public safety and convenience, where:
1. multi-lane vehicular traffic must be diverted into single lane vehicular traffic,
2. vehicular traffic must change lanes abruptly,
3. construction equipment must enter or cross vehicular traffic lanes and walks,
4. construction equipment may intermittently encroach on vehicular traffic lanes and unprotected walks and crosswalks,
5. traffic regulation is needed due to rerouting of vehicular traffic around the Work site, and
6. where construction activities might effect public safety and convenience.

B. Use of Flagmen to assist in the regulation of traffic flow and movement does not relieve Contractor of responsibility to take other means necessary to protect the Work and public.

3.09 INSTALLATION STANDARDS

A. Place temporary pavement for single lane closures, in accordance with TMUTCD.

B. Reinstall temporary and permanent pavement markings as approved by Project Manager. When weather conditions do not allow application according to manufacture’s requirements, alternate markings may be considered. Submit proposed alternate to Project Manager for approval prior to installation. No additional payment will be made for use of alternate marking.

3.10 MAINTENANCE OF EQUIPMENT AND MATERIAL

A. Submit name, address and telephone number of individual designated to be responsible for maintenance of traffic handling at construction site to Project Manager. Individual must be accessible at all times to immediately correct deficiencies in equipment and materials used to handle traffic including missing, damaged, or obscured signs, drums, barricades, or pavement markings.

B. Inspect signs, barricades, drums, lamps and temporary pavement markings daily to verify that they are visible, in good working order, and conform to traffic handling plans as approved by Project Manager. Immediately repair, clean relocate realign, or replace equipment or materials that are not in compliance.

C. Keep equipment and materials, signs and pavement markings, clean and free of dust, dirt, grime, oil, mud, or debris.

D. Obtain approval of Project Manager to reuse damaged or vandalized signs, drum, and barricades.

END OF SECTION

SECTION 01 56 39
TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes the protection and trimming of existing trees that interfere with, or are affected by, execution of the Work, whether temporary or permanent construction.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.
   1. Related Sections include:
      a. Division 01 Section “Summary” for limits placed on Contractor's use of the site.
      b. Division 01 Section “Temporary Facilities and Controls” for temporary tree protection.
      c. Division 31 Section “Site Clearing” for removal limits of trees, shrubs, and other plantings affected by new construction.
      d. Division 31 Section “Earth Moving” for building and utility trench excavation, backfilling, compacting and grading requirements, and soil materials.

1.03 DEFINITIONS

A. Tree Protection Zone: Area surrounding individual trees or groups of trees to remain during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.04 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures".

B. Product Data: For each type of product indicated.

C. Tree Pruning Schedule: Written schedule from arborist detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

D. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

1.05 QUALITY ASSURANCE

A. This Section outlines only minimum standards and requirements. Refer to the Drawings and other sections of the specifications for additional requirements. Bring all conflicts and discrepancies to the attention of the Architect and Landscape Architect, and do not start work until such conflicts and discrepancies are clarified and corrected.

B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed tree protection and trimming work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of tree protection and trimming.

C. Arborist Qualifications: An arborist certified by ISA or licensed in the jurisdiction where Project is located.

D. Tree Pruning Standard: Comply with ANSI A300 (Part 1), “Tree, Shrub, and Other Woody Plant Maintenance--Standard Practices (Pruning).”

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section “Project Management and Coordination.”

1. Before tree protection and trimming operations begin, meet with representatives of authorities having jurisdiction, Owner, Architect, consultants, and other concerned entities to review tree protection and trimming procedures and responsibilities.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Drainage Fill: Selected crushed stone, or crushed or uncrushed gravel, washed, ASTM D 448, Size 24, with 90 to 100 percent passing a 2-1/2-inch sieve and not more than 10 percent passing a 3/4-inch sieve.

B. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 1 inch in diameter; and free of weeds, roots, and toxic and other nonsoil materials.
   1. Obtain topsoil only from well-drained sites where topsoil is 4 inches deep or more; do not obtain from bogs or marshes.

C. Filter Fabric: Manufacturer's standard, nonwoven, pervious, geotextile fabric of polypropylene, nylon, or polyester fibers.

D. Chain-Link Fence: Metallic-coated steel chain-link fence fabric of 0.120-inch-diameter wire; a minimum of 48 inches high; with 1.9-inch-diameter line posts; 2-3/8-inch-diameter terminal and corner posts; 1-5/8-inch-diameter top rail; and 0.177-inch-diameter
   1. bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.

PART 3 - EXECUTION

3.01 PREPARATION

A. Temporary Fencing: Install temporary fencing around tree protection zones to protect remaining trees and vegetation from construction damage. Maintain temporary fence and remove when construction is complete.
   1. Install chain-link fence according to ASTM F 567 and manufacturer's written instructions.

B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

C. Do not store construction materials, debris, or excavated material inside tree protection zones. Do not permit vehicles or foot traffic within tree protection zones; prevent soil compaction over root systems.

D. Maintain tree protection zones free of weeds and trash.

E. Do not allow fires within tree protection zones.

3.02 EXCAVATION

A. Install shoring or other protective support systems to minimize sloping or benching of excavations.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks and comb soil to expose roots.
   1. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction.
   2. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain

in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil Protect construction exposed by or for quality-control service activities.

D. Where utility trenches are required within tree protection zones, tunnel under or around roots by drilling, auger boring, pipe jacking, or digging by hand.
   1. Root Pruning: Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots with sharp pruning instruments; do not break or chop.

3.03 REGRADING

A. Grade Lowering: Where new finish grade is indicated below existing grade around trees, slope grade beyond tree protection zones. Maintain existing grades within tree protection zones.

B. Minor Fill: Where existing grade is 6 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

C. Moderate Fill: Where existing grade is more than 6 inches but less than 12 inches below elevation of finish grade, place drainage fill, filter fabric, and topsoil on existing grade as follows:
   1. Carefully place drainage fill against tree trunk approximately 2 inches above elevation of finish grade and extend not less than 18 inches from tree trunk on all sides. For balance of area within drip-line perimeter, place drainage fill up to 6 inches below elevation of grade.
   2. Place filter fabric with edges overlapping 6 inches minimum.
   3. Place fill layer of topsoil to finish grade. Do not compact drainage fill or topsoil. Hand grade to required finish elevations.

3.04 TREE PRUNING

A. Prune trees to remain that are affected by temporary and permanent construction.

B. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.

C. Pruning Standards: Prune trees according to ANSI A300 (Part 1).

D. Cut branches with sharp pruning instruments; do not break or chop.

E. Chip removed tree branches and dispose of off-site.

3.05 TREE REPAIR AND REPLACEMENT

A. Promptly repair trees damaged by construction operations within 24 hours. Treat damaged trunks, limbs, and roots according to arborist's written instructions.

B. Remove and replace trees indicated to remain that die or are damaged during construction operations that arborist determines are incapable of restoring to normal growth pattern.
   1. Provide new trees of 6-inch caliper size and of a species selected by Architect when damaged trees more than 6 inches in caliper size, measured 12 inches above grade, are required to be replaced.

3.06 DISPOSAL OF WASTE MATERIALS

A. Burning is not permitted.

B. Disposal: Remove excess excavated material and displaced trees from Owner's property.

END OF SECTION

SECTION 01 56 61
TRENCH SAFETY SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section Includes:
   1. Trench Safety System for trench excavation in materials other than solid rock or where otherwise required.
   2. Trench safety system requirements will apply to larger open excavations if erection of structures or other installations limits space between the excavation slope and the installation to dimensions equivalent of a trench, as defined.

B. Related Section: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 DEFINITIONS

A. “Trench” means a narrow excavation (in relation to its depth) made below the surface of the ground. In general, the depth is greater than the width.
   1. Width of Trench (Measured at the Bottom): Generally, not greater than 15 feet.
   2. Depth: Generally greater than 5 feet.

B. Trench safety systems include both Protective Systems and Shoring Systems but are not limited to sloping, sheeting, trench boxes or trench shields, side rail systems, sheet piling, cribbing, bracing, dewatering or diversion of water to provide adequate drainage.
   1. “Protective System” means a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of an adjacent structure.
   2. “Shoring System” means a structure that supports the sides of an excavation and which is designed to prevent cave-ins, or to prevent movement of ground affecting adjacent installations or improvements.

1.04 MEASUREMENT AND PAYMENT

A. Measurement for trench safety systems used on trench excavations is on a lump sum for each separate trench requiring trench safety.

B. Payment for trench safety work will be made in proportion to percent complete of each type of trench safety work, on a line-item basis. Include in the Schedule of Values a line item for the value for trench safety work for each separate trench requiring trench safety.

1.05 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures"

B. For information only, submit the following:
   1. Safety program specifically for construction of trench excavation. Design the trench safety program following OSHA 29CFR standards governing presence and activities of individuals working in and around trench excavations.
   2. Certificate signed and sealed by a qualified professional engineer, stating that the Trench Safety System is designed in conformance with regulatory requirements.

C. Submission of the safety program to the Architect will not constitute request for review or approval by the Architect nor relieve Contractor of obligations under State and Federal trench safety laws.

1.06 QUALITY ASSURANCE

A. This Section outlines only minimum standards and requirements. Refer to the Drawings and other sections of the specifications for additional requirements. Bring all conflicts and discrepancies to the attention of the Architect, Civil Engineer, Structural Engineer, and do not start work until such conflicts and discrepancies are clarified and corrected.

B. Prepare fabrication and field engineering drawings for Trench Safety Systems sealed as required by OSHA by a licensed professional engineer retained and paid by Contractor.

C. Engineering Responsibility:
   1. Engage a qualified professional engineer to prepare design calculations and fabrication and field engineering drawings.
   2. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Texas and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for Trench Safety Systems similar to those required for this Project.

1.07 REGULATORY REQUIREMENTS

A. Comply with requirements of:
   1. Excavations, Trenching, and Shoring, Federal Occupation Safety and Health Administration (OSHA) Standards, 29CFR, Part 1926, Subpart P, as amended; and applicable regulations adopted by the State of Texas.
   2. Legislation enacted by Texas Legislature regarding Trench Safety Systems, is hereby incorporated, by reference, into this Section. Refer to Texas Health and Safety Code Ann., §756.021 (Vernon 1991).

PART 2 - PRODUCTS

2.01 NOT USED PART 3 - EXECUTION

2.02 INSTALLATION

A. Install and maintain trench safety systems following provisions of OSHA 29CFR.

B. Install specially designed trench safety systems following Contractor's trench excavation safety program and fabrication and engineering drawings for locations and conditions identified in the program.

C. Obtain verification from a competent person, as identified in Contractor's trench excavation safety program, trench boxes and other pre-manufactured systems are certified for actual installation conditions.

2.03 INSPECTION

A. Conduct daily inspections by Contractor or Contractor's independently retained consultant, of trench safety systems to ensure installed systems and operations meet OSHA 29CFR and other personnel protection regulations requirements.

B. If evidence of possible cave-ins or slides is apparent, immediately stop work in the trench and move personnel to safe locations until necessary precautions are taken by Contractor to safeguard personnel.

C. If at any time during its use, the trench safety system is damaged, immediately evacuate personnel from the trench or excavation area and repair the trench safety system.

D. Maintain permanent record of daily inspections.

2.04 FIELD QUALITY CONTROL

A. Verify specific applicability of selected or specially designed trench safety systems to field conditions encountered at each trench.

2.05 REMOVAL

A. Bed and backfill pipe to a point at least one (1) foot above top of pipe prior to removal of any portion of Trench Safety System. Comply with specified requirements for bedding and backfill.

B. Coordinate backfilling and removal of trench supports from bottom of trench upward so that trench safety is maintained. Do not completely remove braces or trench supports until all personnel have evacuated the trench.

C. Backfill trench to within 5 feet of natural ground prior to removal of entire Trench Safety System.

END OF SECTION

SECTION 01 57 10
TPDES REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes documentation to be prepared and signed by Contractor before conducting construction operations, in accordance with the Texas Commission on Environmental Quality (TCEQ) General Permit to Discharge Under the Texas Pollutant Discharge Elimination System (TPDES) General Permit TXR150000 on February 19, 2013 (the Construction General Permit).

B. Implementation, maintenance inspection, and termination of storm water pollution prevention control measures including, but not limited to, erosion and sediment controls, storm water management plans, waste collection and disposal, off-site vehicle tracking, and other appropriate practices shown on the Drawings or specified elsewhere in the Contract.

C. Related Sections: Work of all sections, including Division 01 Sections and Drawings, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 DEFINITIONS

A. Commencement of Construction Activities: The exposure of soil resulting from activities such as clearing, grading, and excavating.

B. Large Construction Activity: Project that:
   1. disturbs five (5) acres or more, or
   2. disturbs less than five (5) acres but is part of a larger common plan of development that will disturb five (5) acres or more of land.

C. Small Construction Activity: Project that:
   1. disturbs one (1) or more acres, but less than (5) five acres, or
   2. disturbs less than (1) one acre, but is part of a larger common plan of development that will ultimately disturb one (1) or more acres, but less than five
      a. (5) acres.

D. TPDES Operator: The person or persons who have day-to-day operational control of the construction activities which are necessary to ensure compliance with the SWP3 for the site or other Construction General Permit conditions.

PART 2 - PRODUCTS

2.01 NOT USED PART 3 - EXECUTION

2.02 SITE SPECIFIC STORM WATER POLLUTION PREVENTION PLAN (SWP3)

A. Prepare a SWP3 following Part III of the Construction General Permit and the Storm Water Management Handbook for Construction Activities issued under City Ordinance Section 47-695 (b). If conflicts exist between the Construction General Permit and the handbook, the more stringent requirements will apply.

B. Update or revise the SWP3 as needed during the construction following Part III, Section E or the Construction General Permit.

C. Submit the SWP3 and any updates or revisions to the Architect/Engineer for review and address comments prior to commencing, or continuing, construction activities.

2.03 NOTICE OF INTENT FOR LARGE CONSTRUCTION ACTIVITY

A. Fill out, sign, and date TCEQ Form 20022 (03/05/2013) Notice of Intent (NOI) if required for Storm Water Discharges Associated with Construction Activity under the TPDES Construction General Permit (TXR 150000)

B. Transmit the signed Contractor's copy of TCEQ Form 20022 (03/05/2013), along with required fee to Texas Commission on Environmental Quality along with the completed Payment Submittal Form.

C. Submission of the Notice of Intent form to TCEQ is required a minimum of two (2) days before Commencement of Construction Activities.

2.04 CONSTRUCTION SITE NOTICE FOR SMALL CONSTRUCTION ACTIVITY

A. Fill out sign and date the Construction Site Notice, Attachment 2 to TPDES General Permit TXR150000. "Construction Site Notice",

B. Transmit the signed Construction Site Notice to the City of Houston at least seven (7) days prior to Commencement of Construction Activity.

2.05 CERTIFICATION REQUIREMENTS

A. Conduct inspections in accordance with TCEQ requirements. Ensure persons or firms responsible for maintenance and inspection of erosion and sediment control measures read, fill out, sign, and date the Erosion Control Contractor's Certification for Inspection and Maintenance. Use the EPA NPDES Construction Inspection Form and Storm Water Pollution Prevention Plan.

2.06 RETENTION OF RECORDS

A. Keep a copy of this document and the SWP3 in a readily accessible location at the construction site from Commencement of Construction Activity until submission of the Notice of Termination (NOT) for Storm Water Discharges Associated with Construction Activity under TPDES Construction General Permit (TXR150000). Contractors with day-to-day operational control over SWP3 implementation shall have a copy of the SWP3 available at a central location, on-site, for the use of all operators and those identified as having responsibilities under the SWP3. Upon submission of the NOT, submit all required forms and a copy of the SWP3 with all revisions to Project Manager.

2.07 REQUIRED NOTICES

A. Post the following notices form effective date of the SWP3 until date of final site stabilization as defined in the Construction General Permit;
   1. Post the TPDES permit number for Large Construction Activity, or a signed TCEQ Construction Site Notice for Small Construction Activity. Signed copies of the City's and Contractor's NOI must also be posted.
   2. Post notices near the main entrance of the construction site in a prominent place for public viewing, Post name and telephone number of Contractor's local contact person, brief project description and location of the SWP3.
   3. Post a notice to equipment and vehicles operators, instructing them to stop, check, and clean tires of debris and mud before driving onto traffic lanes. Post at each stabilized construction exit area.
   4. Post a notice of waste disposal procedures in a readily visible location on site.

2.08 ON-SITE WASTE MATERIAL STORAGE

A. On-site waste material storage shall be self-contained and shall satisfy appropriate local, state, and federal rules and regulations.

B. Prepared list of waste material to be stored on-site. Update list as necessary to include up-to-date information. Keep a copy of updated list with the SWP3.

C. Prepare description of controls to reduce pollutants generated form on-site storage. Include storage practices necessary to minimize exposure of materials to storm water, and spill prevention and response measures consistent with best management practices. Keep a copy of the description with the SWP3.

2.09 NOTICE OF TERMINATION

A. Submit a NOT if required to the City of Houston within 30 days after:
   1. Final stabilization has been achieved on all portions of the site that are the responsibility of the Contractor; or
   2. Another operator has assumed control erosion controls over all areas of the site that have not been stabilized; and
   3. All silt fences and other temporary erosion controls have either been removed, schedule to be removed as defined in the SWP3, or transferred to a new operator if the new operator has sought permit coverage.

END OF SECTION

SECTION 01 57 30
FILTER FABRIC FENCE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes installation of erosion and sediment control filter fabric fences used during construction and until final development of the site. The purpose of filter fabric fences is to contain pollutants from overland flow. Filter fabric fences are not for use in channelized flow areas.

B. Related Sections: Work of all sections, including Division 01 Sections and Drawings, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 QUALITY ASSURANCE

A. This Section outlines only minimum standards and requirements. Refer to the Drawings and other sections of the specifications for additional requirements. Bring all conflicts and discrepancies to the attention of the Architect/Engineer and Owner, and do not start work until such conflicts and discrepancies are clarified and corrected.

1.04 REFERENCES

A. ASTM D-3786, Standard Test Method for Hydraulic Bursting Strength for Knitted goods and Nonwoven Fabrics

B. ASTM D-4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

A. Specifications are based on specified product by Mirafi, or Architect/Engineer approved equal. Other manufacturers must have a minimum of five (5) years of experience manufacturing products meeting or exceeding the specifications and comply with Division 01 Section “Product Requirements” regarding substitutions to be considered.

2.02 MATERIAL

A. Filter Fabric: Provide woven or nonwoven geotextile filter fabric made of either polypropylene, polyethylene, ethylene, or polyamide material.
   1. Geotextile fabric shall have a grab strength of 100 psi in any principal direction (ASTM D-4632), Mullen burst strength exceeding 200 psi, and the equivalent opening size between 50 and 140.
   2. Filter fabric material shall contain ultraviolet inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0 degrees Fahrenheit to 120 degrees F.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Preparation, General:
   1. Provide erosion and sediment control systems at locations shown on Drawings. Such systems shall be of the type indicated and shall be constructed in accordance with the requirements shown on Drawings and specified in this Section.

2. No clearing an grubbing or rough cutting shall be permitted until erosion and sediment control systems are in place, other than site work specifically directed by the Architect to allow soil testing and surveying.
3. Maintain existing erosion and sediment control-systems located within the project site until acceptance of the project or until directed by Architect/Engineer to remove and discard the existing system.
4. Regularly inspect and repair or replace damaged components of filter fabric fences as specified in this Section. Unless otherwise directed, maintain the erosion and sediment control systems until the project area stabilization is accepted by the Owner. Remove erosion and sediment control systems promptly when directed by the Architect. Discard removed materials off Site.
5. Remove sediment deposits and dispose of them at designated spoil site for Project. If a project spoil site is not designated on the drawings, dispose of sediment off site at a location not in or adjacent to a stream or flood plain. Off-site disposal is the responsibility of Contractor. Sediment placed at Project Site should be spread evenly throughout site, compacted and stabilized. Sediment shall not be allowed to flush into a stream or drainage way. If sediment has been contaminated, dispose of in accordance with existing federal, state, and locate rules and regulations.
6. Equipment and vehicles shall be prohibited by Contractor from maneuvering on areas outside of dedicated rights-of-way and easements for construction. Damage caused by construction traffic to erosion and sediment control systems shall be repaired immediately.
7. Conduct all construction operations under this Contract in conformance with the erosion control practices described in Division 01 Section "Erosion and Sedimentation Source Controls".

B. Installation:
1. Provide filter fabric fence installed in such a manner that surface runoff will percolate through system in sheet flow fashion and allow sediment to be retained and accumulated.
2. Attach filter fabric to 1 x 2 wooden stakes spaced maximum 3 feet on center and embedded a minimum of 8 inches. If filter fabric is factory preassembled with support netting, then maximum spacing allowable is 6 feet. Install wooden stakes at a slight angle toward source of anticipated runoff.
3. Trench in the toe of filter fabric fence with a spade or mechanical trencher so that downward face of trench is flat and perpendicular to direction of flow as shown on the Storm Water Pollution Prevention Plan (SWPPP). Lay filter fabric along the edges of the trench. Backfill and compact trench.
4. Provide filter fabric fence minimum 18-inch high and a maximum 36-inch high above natural ground.
5. Provide the filter fabric in continuous rolls and cut to length of fence to minimize use of joints. When joints are necessary, splice the fabric together only at a support post with a minimum 6-inch overlap and seal securely.
6. Inspect sediment filter barrier systems after each rainfall, daily during periods of prolonged rainfall, and at a minimum once each week. Repair or replace damaged sections immediately. Remove sediment deposits when silt reaches a depth one-third the height of the fence or 6-inches, whichever is less.

END OF SECTION

SECTION 01 57 40
REINFORCED FILTER FABRIC BARRIER

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes installation of reinforced filter fabric barriers for erosion and sediment control used during construction until final development of Site. Use reinforced filter fabric barriers to retain sedimentation in channelized flow areas.

B. Related Sections: Work of all sections, including Division 01 Sections and Drawings, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 QUALITY ASSURANCE

A. This Section outlines only minimum standards and requirements. Refer to the Drawings and other sections of the specifications for additional requirements. Bring all conflicts and discrepancies to the attention of the Architect/Engineer and Owner, and do not start work until such conflicts and discrepancies are clarified and corrected.

1.04 REFERENCES

A. ASTM D3786, Standard Test Method for Hydraulic Bursting Strength for Knitted goods and Nonwoven Fabrics

B. ASTM D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

A. Specifications are based on Mirafi 140NS, or Architect/Engineer approved equal. Other manufacturers must have a minimum of five (5) years experience manufacturing products meeting or exceeding the specifications and comply with Division 01 requirements regarding substitutions to be considered.

2.02 MATERIAL

A. Filter Fabric: Provide woven or nonwoven geotextile filter fabric of polypropylene, polyethylene, ethylene, or polyamide material.
   1. Physical Properties: Provide filter fabric with minimum grab strength of 100 psi in any principal direction (ASTM D-4632), Mullen burst strength exceeding 200 psi, and equivalent opening size between 50 and 140.
   2. Durability: Provide filter fabric with ultraviolet inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0 degrees Fahrenheit to 120 degrees F.

B. Fencing:
   1. Provide galvanized welded steel wire fence with minimum thickness of 14 gauge and a maximum mesh spacing of 6 inches.
   2. Provide galvanized 2-inch by 4-inch welded wire fabric, 12-1/2 gauge.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Preparation and Installation:

1. Provide erosion and sediment control systems at locations shown on the Storm Water Pollution Prevention Plan (SWPPP) and specified in this Section.
2. No clearing and grubbing or rough cutting shall be permitted until erosion and sediment control systems are in place, other than as specifically directed by the Architect/Engineer to allow soil testing and surveying.

B. Maintain existing erosion and sediment control systems located within the project site until acceptance of the Project or until directed by the Architect/Engineer to remove and discard the existing system.

C. Regularly inspect and repair or replace damaged components of reinforced filter fabric barrier as specified in this Section. Unless otherwise directed, maintain the erosion and sediment control systems until project area stabilization is accepted by the Architect/Engineer. Remove erosion and sediment control systems promptly when directed by Architect/Engineer. Discard removed materials off Site.

D. Remove sediment deposits and dispose of them at designated spoil site for Project. If a project spoil site is not designated on the Storm Water Pollution Prevention Plan (SWPPP), dispose of sediment off Site at a location not in or adjacent to a stream or flood plain. Off-Site disposal is the responsibility of Contractor. Sediment to be placed at the Project Site should be spread evenly throughout Site, compacted and stabilized. Sediment shall not be allowed to flush into a stream or drainage way. If sediment has been contaminated, it shall be disposed of in accordance with existing federal, state, and local rules and regulations.

E. Equipment and vehicles shall be prohibited by the Contractor from maneuvering on areas outside of dedicated rights-of-way and easements for construction. Damage caused by construction traffic to erosion and sediment control systems shall be repaired immediately.

F. Conduct all construction operations under this Contract in conformance with the erosion control practices described in Division 01 Section - Source Controls for Erosion and Sedimentation.

G. Filter Fabric Fence Construction and Monitoring:
1. Provide filter fabric barriers in accordance with the Storm Water Pollution Prevention Plan (SWPPP) Drawing detail for Reinforced Filter Fabric Barrier. Filter fabric barrier systems shall be installed in such a manner that surface runoff will percolate through the system in sheet flow fashion and allow sediment to be retained and accumulated.
2. Attach woven wire support to 1-inch by 2-inch wooden stakes spaced a maximum of 6 feet apart and embedded a minimum of 8 inches. Install wooden stakes at a slight angle toward the source of the anticipated runoff.
3. Trench in toe of filter fabric barrier with a spade or mechanical trencher so that downward face of trench is flat and perpendicular to direction of flow as shown on the Storm Water Pollution Prevention Plan (SWPPP) Drawings. Lay filter fabric along the edges of the trench. Backfill and compact trench.
4. Securely fasten the filter fabric material to the woven wire with tie wires.
5. Reinforced filter fabric barrier shall have a height of 18 inches.
6. Provide filter fabric in continuous rolls and cut to the length of fence to minimize joints. When joints are necessary, splice fabric together only at support posts with a minimum 6-inch overlap and seal securely.
7. Inspect reinforced filter fabric barrier systems after each rainfall, daily during periods of prolonged rainfall, and at a minimum once each week. Repair or replace damaged sections immediately. Remove sediment deposits when silt reaches a depth one-third the height of the barrier or 6 inches, whichever is less.

END OF SECTION

SECTION 01 57 50
STABILIZED CONSTRUCTION EXIT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes furnishing and installing erosion and sediment control for stabilized construction exits used during construction and until final development of the site.

B. Related Sections: Work of all sections, including Division 01 Sections and Drawings, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 REFERENCES

A. ASTM D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

A. Specifications are based on specified product by Mirafi, or Architect/Engineer approved equal. Other manufacturers must have a minimum of five (5) years experience manufacturing products meeting or exceeding the specifications and comply with Division 01 Section “Product Requirements” regarding substitutions to be considered.

2.02 MATERIAL

A. Geotextile Fabric:
   1. Provide woven or non-woven geotextile fabric made of polypropylene, polyethylene, ethylene, or polyamide material.
   2. Geotextile fabric shall have a minimum grab strength of 270 psi in any principal direction (ASTM D-4632), and the equivalent opening size between 50 and 140.
   3. Both the geotextile and threads shall be resistant to chemical attack, mildew, and rot and shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable life at a temperature range of 0 degrees Fahrenheit to 120 degrees F.

B. Coarse Aggregates:
   1. Provide material consisting of crushed stone, gravel, crushed blast furnace slag, or a combination of these materials that are clean, hard, durable materials free from adherent coatings, salt, alkali, dirt, clay, loam, shale, soft or flaky materials, or organic and injurious matter.
   2. Coarse aggregates shall conform to the following gradation requirements.

Sieve Size	Percent Retained
(Square Mesh)	(By Weight)
2-1/2 inch	0
2 inch	0 - 20
1-1/2 inch	15 - 50
3/4 inch	60 - 80
No. 4	95 - 100

PART 3 - EXECUTION

3.01 INSTALLATION

A. Preparation and Installation:

1. If necessary to keep the street clean of mud carried by construction vehicles and equipment, Contractor shall provide stabilized construction roads and exits at the construction, staging, parking, storage, and disposal areas. Such erosion and sediment controls shall be constructed in accordance with the requirements shown on the Drawings and specified in this Section.
2. No clearing and grubbing or rough cutting shall be permitted until erosion and sediment control systems are in place, other than as specifically directed by the Engineer to allow soil testing and surveying.
3. Maintain existing erosion and sediment control systems located within the Project Site until acceptance of the Project or until directed by the Architect/Engineer to remove and discard the existing system.
4. Regularly inspect and repair or replace components of stabilized construction exits. Unless otherwise directed, maintain the stabilized construction roads and exits until the Project is accepted by the Owner. Remove stabilized construction roads and exits promptly when directed by the Architect/Engineer. Discard removed materials off site.
5. Remove excess excavated material and sediment deposits and provide legal disposal of them off Project Site at location not in or adjacent to a stream or flood plain. Off-site disposal is the responsibility of the Contractor. Sediment to be placed at the project site should be spread evenly within areas indicated to be re-graded. Sediment shall not be allowed to flush into a stream or drainage way. If sediment has been contaminated, it shall be disposed of in accordance with existing federal, state, and local rules and regulations.
6. Equipment and vehicles shall be prohibited by the Contractor from maneuvering on areas outside of dedicated rights-of-way and easements for construction. Immediately repair damage caused by construction traffic to erosion and sediment control systems.
7. Conduct all construction operation under this Contract in conformance with the erosion control practices described in Division 01 Section "Erosion and Sedimentation Source Controls".

B. Construction Methods:
1. Provide stabilized access roads, parking areas, wash-off areas, and other on-site vehicle transportation routes where approved by Architect/Engineer and Owner's Representative.
2. Provide stabilized construction exits, and truck washing areas as approved by Architect/Engineer, and of the sizes and locations approved by the Owner's Representative.
3. Vehicles leaving construction areas shall have their tires cleaned to remove sediment prior to entrance onto public right-of-way. When washing is needed to remove sediment, Contractor shall construct a truck washing area. Truck washing shall be done on stabilized areas which drain into a drainage system protected by erosion and sediment control measures.
4. The length of the stabilized area shall be not less than 50 feet. The thickness shall not less than 8 inches. The width shall not be less 14 feet for one-way traffic and 20 feet for two-way traffic and shall be sufficient for all ingress and egress. Stabilized area may be widened or lengthened to accommodate truck washing area. Stabilization for other areas shall have the same coarse aggregate, thickness, and width requirements as the stabilized construction exit.
5. Furnish and place geotextile fabric as a permeable separator to prevent mixing of coarse aggregate with underlying soil. Exposure of geotextile fabric to the elements between laydown and cover shall be a maximum of 14 days to minimize damage potential.
6. Roads and parking areas shall be graded to provide sufficient drainage away from stabilized areas. Use sandbags, gravel, boards, or similar methods to prevent sediment from entering public right-of-way, receiving stream or storm water conveyance system.

7. Inspect and maintain stabilized areas daily. Provide periodic top dressing with additional coarse aggregates too maintain the required depth. Repair and clean out damaged control measures used to trap sediment. All sediment spilled, dropped, washed, or tracked onto public right-of-way shall be removed immediately.

END OF SECTION

SECTION 01 57 60
WASTE MATERIAL DISPOSAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes disposal of waste material and salvageable material. Also refer to Division 01 Section "Construction Waste Management".

B. Related Sections: Work of all sections, including Division 01 Sections and Drawings, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures".

B. Submit a copy of an approved "Development Permit", as defined in Chapter 19 of the Flood Plain Ordinance (City Ordinance Number 81-914 and Number 85-1705), prior to disposal of excess material in areas designated as being in a "100-year Flood Hazard Area" within the City. Contact the Harris County Flood Control District (HCFCD), City of Houston Floodplain Administrator, 3300 Main Street, at (713) 525-7823 for floodplain information.

C. Obtain and submit disposal permits for proposed disposal sites if required by local ordinances.

D. Submit a copy of written permission from property owner, along with description of property, prior to disposal of excess material adjacent to the Project. Submit a written and signed release from property owner upon completion of disposal work.

PART 2 - PRODUCTS

2.01 NOT USED

PART 3 - EXECUTION

3.01 SALVAGEABLE MATERIAL

A. Excavated Material: When indicated on Drawings, load, haul, and deposit excavated material at a location or locations shown on Drawings outside the limits of Project.

B. Other Salvageable Materials: Conform to requirements of Section Division 32 Section for site clearing.

3.02 EXCESS MATERIAL

A. Vegetation, rubble, broken concrete, debris, asphaltic concrete pavement, excess soil, and other materials not designated for salvage, shall become the property of Contractor and shall be removed from the job site and legally disposed of.

B. Excess soil may be deposited on private property adjacent to the Project when written permission is obtained from property owner.

C. Verify the flood plain status of any proposed disposal site. Do not dispose of excavated materials in an area designated as within the 100-year Flood Hazard Area unless a “Development Permit” has been obtained. Excess material placed in a "100-year Flood Hazard Area" within the City, without a "Development Permit", shall be removed by Contractor at no additional cost to the Owner.

D. Waste materials shall be removed from the site on a daily basis, such that the site is maintained in a neat and orderly condition.

END OF SECTION

SECTION 01 57 70
GRAVEL BAGS FOR EROSION CONTROL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes furnishing, installing, maintaining, and removing temporary erosion protection and sediment control gravel bag in accordance with these specifications and construction drawings, and as directed by the Engineer. Gravel bag are geotextile fabric bags filled with clean gravel and placed around a stage II inlet, such as a curb inlet. This work shall be performed during construction operations and prior to final stabilization to control erosion and sedimentation.

B. Related Sections: Work of all sections, including Division 01 Sections and Drawings, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Bags shall consist of geotextile fabric (filter fabric) made of long-chain synthetic polymers composed of at least 95 percent by weight of polyolefins in a woven fabric. The geotextile fabric properties shall equal or exceed the stated property values listed in Table 1 below:

Table 1 Silt Fence Geotextile Fabric Properties			Requirements Unsupported Silt Fence	
	Units	Supported Silt Fence	Geotextile Elongation >=50%	Geotextile Elongation <50%
Grab Strength				
Machine Direction	lbs.	90	123	123
	lbs.	90	100	100
Permittivity	sec-1	0.05	0.05	0.05
Apparent Opening Size (maximum average roll value)	mm/sieve	0.6/30	0.6/30	0.6/30
Ultraviolet Stability (Retained Tensile Strength)	%	70 after 500 hrs exposure	70 after 500 hrs exposure	70 after 500 hrs exposure

B. Geotextile fabric shall contain stabilizers and/or inhibitors to make the fabric resistant to deterioration resulting from exposure to sunlight or heat. Geotextile fabric shall be resistant to commonly encountered soil chemicals, mildew, rot, and insects. Geotextile fabric shall be free of defects or flaws that affect its physical and/or filtering properties. Geotextile fabric shall provide an expected useable life comparable to the anticipated construction period.

1. The bag size shall be as follows:
2. Length: 18 to 24 inches

3. Width: 12 to 18 inches
4. Thickness: 6 to 8 inches
5. The bag shall be filled with open-graded gravel and weigh 50 to 125 pounds. The gravel shall be free from adherent coatings, salt, alkali, dirt, clay, or organic and injurious matter. Clean coarse sand may be substituted for the open-graded gravel only as approved by the Engineer.
6. Nylon rope shall be used to secure the closure of the gravel filled bag.

PART 3 - EXECUTION

3.01 CONSTRUCTION METHODS

A. No clearing and grubbing or rough cutting, other than as specifically directed by the Engineer to allow for soil testing, surveying and installation of erosion protection and sediment control measures, shall be permitted until sediment control and erosion protection systems are in-place.

B. Gravel bag shall be installed at the locations shown on the construction drawings and in accordance with the drawing or as directed by the Engineer. Gravel bag shall be constructed in accordance with an approved schedule that clearly describes the timing during the construction process that the various erosion control measures will be implemented. Gravel bag shall be installed so as surface runoff will percolate through the system and allow sediment to be retained and accumulated.

C. Gravel bags for the inlet protection barrier shall be placed so as the gravel bags are placed on each side of the curb inlet along the gutter line and continuously along the back of the curb inlet. Gravel bags shall not be placed so as the throat of the inlet is blocked. Gravel bags shall be placed in a row with ends tightly abutting the adjacent bag.

D. The Contractor shall inspect the gravel bag at least once every fourteen calendar days, within 24-hours of the end of a storm event of 0.5 inches rainfall or greater, and daily
   1. during prolonged rainfalls. The Contractor shall remove irregularities which will impede normal flow. Erosion protection and sediment control systems shall be maintained by the Contractor until final stabilization. Damage caused to erosion protection and sediment control systems shall be repaired immediately.

E. The Contractor is responsible for removal and proper disposal of sediment and debris from the inlet protection barrier system and as directed by the Engineer. Sediment and debris shall not be allowed to flush into the storm sewer system, waterways, jurisdictional wetlands, or onto adjacent properties. Sediment deposits shall be removed before they reach one-third of the height of the gravel bags.

F. Uncontaminated sediment can be placed at the project spoil site or, if properly handled, spread out to supplement fill requirements. The Engineer will designate how the sediment deposits are to be handled. Uncontaminated sediment shall not be placed in waterways or jurisdictional wetlands, unless as approved by the Engineer. If sediment has been contaminated, then it shall be disposed of in accordance with the applicable federal, state, and local regulations. Offsite disposal shall be the responsibility of the Contractor.

G. After final stabilization and at the direction of the Engineer, the Contractor, when required, shall be responsible for removing all erosion protection and sediment control systems that are not permanent, from the project.

3.02 QUALITY ASSURANCE

A. The Contractor is responsible for the control of the quality of materials incorporated into the construction and the quality of completed construction. The County will engage materials engineering services to provide quality assurance testing and inspection to assist the County Engineer in determining the acceptability of materials and completed construction. Quality assurance services provided by the County do not relieve the Contractor of his responsibility for

quality control. The Materials Engineer shall not have control of the means, methods, techniques, sequences or procedures of construction selected by the Contractor.

3.03 MEASUREMENT AND PAYMENT

A. When paid for separately as a pay item, measurement and payment for the gravel bag inlet protection barrier for a stage II inlet shall be by the linear foot, complete and in-place, measurement being along the centerline of the inlet protection barrier, between the limits of the beginning and ending gravel bag. Payment for a gravel bag shall include and be full compensation for all labor, equipment, materials, supervision, and all incidental expenses for construction of this item, complete and in-place, including but not limited to furnishing and placing all materials, maintenance requirements, repair and replacement of damaged sections, removal and disposal of sediment deposits, and removal and disposal of erosion protection and sediment control systems after final stabilization.

END OF SECTION

SECTION 01 57 80
GROUND AND SURFACE WATER CONTROL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes dewatering, draining, and maintaining trenches, shaft excavations and foundation beds in dry and stable condition; control ground water seepage into excavations; protecting work against surface runoff and rising flood waters; and dispose of removed water.
   1. Provide drainage of seepage water as well as water from any other sources entering excavations. Excavation drainage system may include placement of drainage material, such as crushed stone and filter fabric, together with sump pumping.
   2. Provide ditches, berms, pumps, and other methods necessary to divert and drain surface water from excavations and other work.
   3. Locate ground water control and drainage systems so as not to interfere with utilities, construction operations, adjacent properties, or adjacent water wells.
   4. Assume sole responsibility for ground water control systems and for loss or damage resulting from partial or complete failure of protective measures and settlement or resultant damage caused by the ground water control operations. Modify ground water control systems or operations if they cause or threaten to cause damage to new construction, existing site improvements, adjacent property, or affect potentially contaminated areas. Repair damage caused by ground water control systems or resulting from failure of the system to protect property as required.
   5. Monitor ground water discharge for contamination while performing pumping in the vicinity of potentially contaminated sites.

B. Related Sections: Work of all sections, including Division 01 Sections and Drawings, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 REFERENCES

A. ASTM D698 - Standard Test Methods for laboratory compaction of soils using standard effort (12,400 ft-lbf/cu. ft.)

B. Code of Federal Regulations, 29 CFR Part 1926, Standards - Excavation, Occupational Safety and Health Administration (OSHA).

C. “Storm Water Management Handbook for Construction Activities” prepared by the City of Houston, Harris County and Harris County Flood Control District.

1.04 DEFINITIONS

A. Ground Water Control: Provide dewatering and depressurization of water-bearing soil layers open to excavations.

B. Dewatering: Provide removal of seepage emerging from slopes or bottoms of excavations and disposing of removed water.

C. Surface Drainage: Provide temporary drainage ditches and dikes, temporary culverts, and sump pumps with discharge lines, as required to protect the Work from surface water.
   1. PERFORMANCE REQUIREMENTS

D. Provide methods to control surface water, runoff, subsurface water, and water from excavations and structures to prevent damage to the Work, the Site, and adjoining properties.

E. Control fill, grade and ditch to direct water away from excavations, pits, tunnels, and other work areas; and to direct drainage to proper runoff courses to prevent erosion, sedimentation, or damage.

F. Provide, operate, and maintain equipment and facilities of adequate size to control surface water.

G. Dispose of drainage water in conformance with environmental requirements and in a manner to prevent flooding, erosion, or other damage to the site and to adjoining areas.

H. Retain existing drainage patterns external to construction site by constructing temporary earth berms, sedimentation basins, retaining areas, and temporary ground cover for erosion and sedimentation control.

I. Plan and execute construction and earthwork by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.
   1. Hold the area of bare soil exposed at one time to a minimum.
   2. Provide temporary control measures such as berms, dikes, and drains.

J. Plan and execute construction and earthwork by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.

K. Construct fills and waste areas by selective placement to eliminate surface silts or clays that will erode.

L. Inspect earthwork periodically to detect any evidence of start of erosion. Take corrective measures to control erosion.

M. Conduct subsurface investigations to identify groundwater conditions and to provide parameters for design, installation, and operation of groundwater control systems. Submit proposed method and spacing of readings for review prior to obtaining water level readings

N. Design ground water control system, compatible with requirements of Federal Regulations 29 CFR Part 1926 and Division 31 Section “Excavation Support and Protection”.

O. Remove systems upon completion of construction or when dewatering and control of surface or ground water is not longer required.

1.05 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures".

B. Submit a Ground Water and Surface Water Control Plan for Architect's/Engineer's review prior to start of any field work. The Plan shall be signed by a Professional Engineer registered in the State of Texas. Submit a plan to include the following:
   1. Names of equipment suppliers and installation subcontractors.
   2. A description of proposed ground water control systems indicating arrangement and location of system components, installation details and criteria, and operation and maintenance procedures.
   3. A description of proposed filters including types, sizes, capacities and manufacturer’s application recommendations.
   4. Design calculations demonstrating adequacy of proposed systems for intended applications. Define potential area of influence of ground water control operation near contaminated areas.
   5. Surface water control and drainage installations.
   6. Proposed methods and locations for disposing of removed water.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Comply with requirements of agencies having jurisdiction.

B. Obtain TPDES permit under the TPDES Pollutant Discharge Elimination System (TPDES), for storm water discharge from construction sites. Refer to Division 01 Section - TPDES Requirements.

C. Obtain all necessary permits from agencies with control over the use of groundwater and matters affecting water discharge, and use of existing storm drains and natural water sources. Because the review and permitting process may be lengthy, take early action to pursue and submit for the required approvals.

PART 2 - PRODUCTS

2.01 MATERIAL

A. Provide materials and equipment necessary to achieve the performance requirements. Use only equipment that is in good repair and operating order. Provide sufficient standby equipment readily available to ensure continuous operation, in the event primary equipment becomes inoperative.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Ground Water Control:
   1. Install, operate, and maintain ground water control systems in accordance with the Ground Water and Surface Water Control Plan and to achieve performance requirements specified.
   2. Provide for continuous system operation, including nights, weekends, and holidays. Arrange for appropriate backup if electrical power is primary energy source for dewatering system.
   3. Monitor operations to verify that the system removes ground water seepage at a rate required to maintain a dry excavation resulting in a stable subgrade for prosecution of subsequent operations.
   4. Remove system upon completion of construction or when dewatering and control of surface or ground water is no longer required.
   5. Backfill and compact excavations performed for convenience of dewatering; See Division 31 Section “Earthwork” for requirements.

B. Surface Water Control:
   1. Intercept surface water and divert it away from excavations through use of dikes, ditches, curbs, walls, pipes, sumps or other approved means. The requirement includes temporary works required to protect adjoining properties from surface drainage caused by construction operations. Contractor to anticipate, prepare and construct temporary drainage system as required to drain surface water from the site and also from the roof drainage from the buildings.
   2. Divert surface water and seepage water into sumps and pump it into drainage channels or storm drains, when approved by agencies having jurisdiction. Provide settling basins when required by such agencies.

END OF SECTION

SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes the following administrative and procedural requirements:
   1. Selection of products for use in Project; product.
   2. Delivery, storage, and handling.
   3. Manufacturers' standard warranties on products and special warranties.
   4. Product options, substitutions, and comparable products.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 DEFINITIONS

A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term “product” includes the terms “material,” “equipment,” “system,” and terms of similar intent.
   1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
   2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
   3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words “basis of design,” including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other
   1. characteristics for purposes of evaluating comparable products of other named manufacturers.

D. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

E. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

1.04 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures".

B. Substitution Requests: Submit one electronic copy of each request for consideration. No faxes will be accepted. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use form approved by Architect.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    a. Statement indicating why specified material or product cannot be provided.
    b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
    c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
    d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
    e. Samples, where applicable or requested.
    f. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
    g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
    h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
    i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
    j. Cost information, including a proposal of change, if any, in the Contract Sum.
    k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
    l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
    a. Form of Acceptance: Change Order.
    b. Use product specified if Architect cannot make a decision on use of a proposed substitution within time allocated.

C. Product List: Submit a list, in tabular from, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
1. Coordinate product list with Contractor's Construction Schedule and the Submittals Schedule.
2. Form: Tabulate information for each product under the following column headings:
    a. Specification Section number and title.
    b. Generic name used in the Contract Documents.
    c. Proprietary name, model number, and similar designations.
    d. Manufacturer's name and address.
    e. Supplier's name and address.
    f. Installer's name and address.
    g. Projected delivery date or time span of delivery period.

h. Identification of items that require early submittal approval for scheduled delivery date.

3. Completed List: Within 30 days after date of commencement of the Work, submit one electronic copy of completed product list. Include a written explanation for omissions of data and for variations from Contract requirements.
4. Architect's Action: Architect will respond in writing to Contractor within 15 days of receipt of completed product list. Architect's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. Architect's response, or lack of response, does not constitute a waiver of requirement that products comply with the Contract Documents.

D. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section “Submittal Procedures.” Show compliance with requirements.

1.05 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
5. Store products to allow for inspection and measurement of quantity or counting of units.
6. Store materials in a manner that will not endanger Project structure.
7. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
9. Protect stored products from damage.

B. Storage: Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.07 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Refer to Divisions 02 through 49 Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Division 01 Section “Closeout Procedures”.

PART 2 - PRODUCTS

2.01 PRODUCT OPTIONS

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that are new at time of installation.
   1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
   2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
   3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
   4. Where products are accompanied by the term “as selected,” Architect will make selection.
   5. Where products are accompanied by the term “match sample,” sample to be matched is Architect's.
   6. Descriptive, performance, and reference standard requirements in the Specifications establish “salient characteristics” of products.
   7. Or Equal: Where products are specified by name and accompanied by the term “or equal” or “or approved equal” or “or approved,” comply with provisions in “Comparable Products” Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures: Procedures for product selection include the following:
   1. Product:
      a. Where Specification paragraphs or subparagraphs titled “Product” name a single product and manufacturer, provide the product named.
      b. Substitutions will not be considered, unless otherwise indicated.
   2. Manufacturer/Source:
      a. Where Specification paragraphs or subparagraphs titled “Manufacturer” or “Source” name single manufacturers or sources, provide a product by the manufacturer or from the source named that complies with requirements.
      b. Substitutions will not be considered, unless otherwise indicated.
   3. Products:
      a. Where Specification paragraphs or subparagraphs titled “Products” introduce a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
      b. Substitutions will not be considered, unless otherwise indicated.
   4. Manufacturers:
      a. Where Specification paragraphs or subparagraphs titled “Manufacturers” introduce a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
      b. Substitutions will not be considered, unless otherwise indicated.
   5. Available Products: Where Specification paragraphs or subparagraphs titled “Available Products” introduce a list of names of both products and manufacturers, provide one of the products listed or another product that complies with requirements. Comply with provisions in “Comparable Products” Article to obtain approval for use of an unnamed product.
   6. Available Manufacturers: Where Specification paragraphs or subparagraphs titled “Available Manufacturers” introduce a list of manufacturers' names, provide a product by one of the manufacturers listed or another manufacturer that complies with requirements. Comply with provisions in “Comparable Products” Article to obtain approval for use of an unnamed product.
   7. Product Options: Where Specification paragraphs titled “Product Options” indicate that size, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide either the specific product or system indicated or a comparable product

or system by another manufacturer. Comply with provisions in “Product Substitutions” Article.

8. Basis-of-Design Products:
    a. Where Specification paragraphs or subparagraphs titled “Basis-of-Design Product[s]” are included and also introduce or refer to a list of manufacturers' names, provide either the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in “Comparable Products” Article to obtain approval for use of an unnamed product.
    b. Substitutions will not be considered, unless otherwise indicated.
9. Visual Matching Specification:
    a. Where Specifications require matching an established Sample, select a product (and manufacturer) that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches satisfactorily.
    b. If no product available within specified category matches satisfactorily and complies with other specified requirements, comply with provisions of the Contract Documents on “substitutions” for selection of a matching product.
10. Visual Selection Specification:
    a. Where Specifications include the phrase “as selected from manufacturer's colors, patterns, textures, or a similar phrase, select a product (and manufacturer) that complies with other specified requirements.
    b. Standard Range: Where Specifications include the phrase “standard range of colors, patterns, textures” or similar phrase, Architect will select color, pattern, or texture from manufacturer's product line that does not include premium items.
    c. Full Range: Where Specifications include the phrase “full range of colors, patterns, textures” or similar phrase, Architect will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.

2.02 PRODUCT SUBSTITUTIONS

A. Timing: Architect will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Architect.

B. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
    1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
    2. Requested substitution does not require extensive revisions to the Contract Documents.
    3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    4. Substitution request is fully documented and properly submitted.
    5. Requested substitution will not adversely affect Contractor's Construction Schedule.
    6. Requested substitution has received necessary approvals of authorities having jurisdiction.
    7. Requested substitution is compatible with other portions of the Work.
    8. Requested substitution has been coordinated with other portions of the Work.
    9. Requested substitution provides specified warranty.
    10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

2.03 COMPARABLE PRODUCTS

A. Where products or manufacturers are specified by name, submit the following, in addition to other required submittals, to obtain approval of an unnamed product:
   1. Evidence that the proposed product does not require extensive revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
   2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
   3. Evidence that proposed product provides specified warranty.
   4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
   5. Samples, if requested.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01 71 00
CLEANING UP

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes the following:
   1. Housekeeping:
      a. No trash shall be allowed to accumulate or be allowed to remain on the premises or job site beyond a reasonable length of time. Trash shall be removed from within the building daily. Particular attention shall be given to these requirements.
      b. All trash shall be removed by means of chutes, hoists, or receptacles. Under no circumstances shall any trash or waste be dropped or thrown from one level to another within or outside the buildings.
      c. Immediately after unpacking materials, all packing case lumber or other packing materials, excelsior, wrappings and other like flammable wastes shall be collected and removed from the buildings and premises. Burning of trash on the site will not be permitted.
      d. Care shall be taken by all workmen not to mark, soil, or otherwise deface any finishes. In the event that any finishes become defaced in any way by mechanics or workmen, the Contractor or any of his Subcontractors shall clean and restore such surfaces to their original condition.
      e. Each Subcontractor engaged upon the work shall bear his full responsibility for leaving all work in a clean and proper condition, satisfactory to the Architect
   2. Final Cleaning:
      a. Remove all marks, stains, fingerprints and other soil or dirt from all painted, decorated and stained work, ceiling and wall surfaces, window frames and glass, doors, and clean as required to leave in first class condition.
      b. Sweep and/or vacuum all surfaces clean prior to final payment.
      c. Upon completion of the work, the Contractor will be required to thoroughly clean the building site and surrounding ground, and all trash left by him in the course of construction of the work shall be removed and disposed of off the site of work.

B. Related Sections: Work of all sections, including Division 01 Sections and Drawings, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

PART 2 - PRODUCTS

2.01 NOT USED

PART 3 - EXECUTION

3.01 NOT USED

END OF SECTION

SECTION 01 73 00
EXECUTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
   1. Construction layout.
   2. Field engineering and surveying.
   3. General installation of products.
   4. Coordination of Owner-installed products.
   5. Progress cleaning.
   6. Starting and adjusting.
   7. Protection of installed construction.
   8. Correction of the Work.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 SUBMITTALS

A. Qualification Data: For land surveyor or professional engineer to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

B. Certificates: Submit certificate signed by land surveyor or professional engineer certifying that location and elevation of improvements comply with requirements.

C. Certified Surveys: Submit 2 copies signed by land surveyor or professional engineer.

D. Final Property Survey: Submit 2 reproducible copies showing the Work performed and record survey data.

1.04 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

PART 2 - PRODUCTS

2.01 NOT USED PART 3 - EXECUTION

2.02 EXAMINATION

A. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
   1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; and underground electrical services.
   2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
    a. Description of the Work.
    b. List of detrimental conditions, including substrates.
    c. List of unacceptable installation tolerances.
    d. Recommended corrections.
2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

2.03 PREPARATION

A. Existing Utility Information: Furnish information to local utility Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
    1. Notify Architect and Owner not less than 2 days in advance of proposed utility interruptions.
    2. Do not proceed with utility interruptions without Owner's written permission.

C. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

D. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

E. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

2.04 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.

B. General: Engage a land surveyor or professional engineer to lay out the Work using accepted surveying practices.
    1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
    2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
    3. Inform installers of lines and levels to which they must comply.
    4. Check the location, level and plumb, of every major element as the Work progresses.
    5. Notify Architect when deviations from required lines and levels exceed allowable tolerances.

6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.

D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

2.05 FIELD ENGINEERING

A. Identification: Owner will identify existing benchmarks, control points, and property corners.

B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

C. Benchmarks: Establish and maintain a minimum of 2 permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.

E. Final Property Survey: Prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor or professional engineer, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official “property survey.”

2.06 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.

3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
4. Maintain minimum headroom clearance of 8 feet in spaces without a suspended ceiling.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
2. Allow for building movement, including thermal expansion and contraction.

G. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

H. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

2.07 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 degrees Fahrenheit.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Cutting and Patching: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

H. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

I. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

J. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

K. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

2.08 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 01 Section “Quality Requirements”.

2.09 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

2.10 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section “Cutting and Patching”.

B. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

C. Restore permanent facilities used during construction to their specified condition.

D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION

SECTION 01 73 29
CUTTING AND PATCHING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes procedural requirements for cutting and patching.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.04 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures".

B. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:

1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
3. Products: List products to be used and firms or entities that will perform the Work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
7. Architect's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.05 QUALITY ASSURANCE

A. This Section outlines only minimum standards and requirements. Refer to the Drawings and other sections of the specifications for additional requirements. Bring all conflicts and discrepancies to the attention of the Architect and do not start work until such conflicts and discrepancies are clarified and corrected.

B. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

C. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.

D. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

E. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Comply with requirements specified in other sections.

B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
   1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
   1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.

B. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.

3.03 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.

3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
5. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
   1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
   2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
      a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
      b. Restore damaged pipe covering to its original condition.
   3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
      a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
   4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
   5. Exterior Building Enclosure (As applicable): Patch components in a manner that restores enclosure to a weathertight condition.

D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION

SECTION 01 74 19
CONSTRUCTION WASTE MANAGEMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for the following, as applicable:
   1. Salvaging nonhazardous construction waste.
   2. Recycling nonhazardous construction waste.
   3. Disposing of nonhazardous construction waste.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of construction waste and subsequent turnover to Owner, sale, or reuse in another facility.

F. Salvage and Reuse: Recovery of construction waste and subsequent incorporation into the Work.

1.04 PERFORMANCE REQUIREMENTS

A. General: Develop waste management plan that results in end-of-Project rates for salvage/recycling of 50 percent by weight of total waste generated by the Work.

1.05 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures".

B. Waste Management Plan: Submit three (3) copies of plan within seven (7) days of date established for commencement of the Work.

C. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit three (3) copies of report. Include the following information, as applicable:
   1. Material category.
   2. Generation point of waste.
   3. Total quantity of waste in tons.
   4. Quantity of waste salvaged, both estimated and actual in tons.
   5. Quantity of waste recycled, both estimated and actual in tons.
   6. Total quantity of waste recovered (salvaged plus recycled) in tons.
   7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

D. Waste Reduction Calculations: Before request for Substantial Completion, submit three
   1. (3) copies of calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

E. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

F. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

G. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

H. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

I. Qualification Data: For Waste Management Coordinator.

1.06 QUALITY ASSURANCE

A. This Section outlines only minimum standards and requirements. Refer to the Drawings and other sections of the specifications for additional requirements. Bring all conflicts and discrepancies to the attention of the Architect, Engineer, and appropriate Consultant and do not start work until such conflicts and discrepancies are clarified and corrected.

B. Regulatory Requirements:
   1. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Waste Management Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination". Review methods and procedures related to waste management including, but not limited to, the following:
   1. Review and discuss waste management plan including responsibilities of Waste Management Coordinator.
   2. Review requirements for documenting quantities of each type of waste and its disposition.
   3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
   4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
   5. Review waste management requirements for each trade.

1.07 WASTE MANAGEMENT PLAN

A. General: Develop plan consisting of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of site-clearing and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
   1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
   2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
   3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
   4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.

5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.
7. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include the following:
8. Total quantity of waste.
9. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
10. Total cost of disposal (with no waste management).
11. Revenue from salvaged materials.
12. Revenue from recycled materials.
13. Savings in hauling and tipping fees by donating materials.
14. Savings in hauling and tipping fees that are avoided.
15. Handling and transportation costs. Include cost of collection containers for each type of waste.
16. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS

2.01 NOT USED PART 3 - EXECUTION

2.02 PLAN IMPLEMENTATION

A. General: Implement waste management plan as approved by Architect. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
   1. Comply with Division 01 Section "Temporary Facilities and Controls" for operation, termination, and removal requirements.

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
   1. Distribute waste management plan to everyone concerned within three (3) days of submittal return.
   2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
   2. Comply with Division 01 Section "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

2.03 RECYCLING CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Owner.

C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.

1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
    a. Inspect containers and bins for contamination and remove contaminated materials if found.
2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste off Owner's property and transport to recycling receiver or processor.

2.04 RECYCLING CONSTRUCTION WASTE

A. Packaging:
    1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
    2. Polystyrene Packaging: Separate and bag materials.
    3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
    4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:
    1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
    2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

C. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location.
    1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

2.05 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
    1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
    2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning or burying debris on site is not permitted.

C. Disposal: Transport waste materials and legally dispose of them off Owner's property.

END OF SECTION

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
   1. Substantial Completion and Final Inspection procedures.
   2. Post-occupancy inspection procedures.
   3. Project Record Documents
   4. Operation and maintenance manuals.
   5. Warranties.
   6. Instruction of Owner's personnel.
   7. Final cleaning.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
   1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
   2. Advise Owner of pending insurance changeover requirements.
   3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
   4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
      a. Apply for and obtain from the Building Official a Temporary Certificate of Occupancy in the Owner's name.
      b. The Certificate is to be obtained and posted as required by the Building Official prior to the final inspection by the Owner.
      c. Temporary Certificate in lieu of a Certificate of Occupancy will be sufficient, as the Owner's prerequisite for his final inspection, only when his specific written approval has been obtained.
   5. Prepare and submit one hard copy and one electronic PDF copy of Project Record Documents (As-Built Drawings) and send both copies to Architect, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information.
   6. Deliver tools, keys, spare parts, extra materials, operation and maintenance manuals, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
   7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
   8. Complete startup testing of systems.
   9. Submit test/adjust/balance records.
   10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

11. Advise Owner of changeover in heat and other utilities.
12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
13. Complete final cleaning requirements, including touchup painting.
14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
15. Change all air conditioning filters and permit Owner or his representative to inspect.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
   1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
   2. Results of completed inspection will form the basis of requirements for Final Completion.

1.04 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
   1. Submit a final Application for Payment according to Division 01 Section Payment Procedures.
   2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
   3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
   4. Submit pest-control final inspection report and warranty.
   5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Inspection:
   1. Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
   2. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.05 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: General Contractor shall be responsible for transcribing and submission of punch list. Architect will walk the Project and assist General Contractor in the development of the list. Submit one electronic copy of list in Microsoft Word format. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
   1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor, where applicable.
   2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
   3. Include the following information at the top of each page:
      a. Project name.
      b. Date.

c. Name of Architect.
d. Name of Contractor.
e. Page number.

1.06 POST-OCCUPANCY INSPECTION

A. Conduct a post-occupancy inspection of the Work in the company of the Owner's Representative and the Owner before expiration of the one-year correction period.
   1. Schedule the post-occupancy inspection not later than 20 days before the end of the one-year correction period.
   2. Provide not less than 5 day's written notice to the Owner prior to the anticipated date of post-occupancy inspection.
   3. Prepare a list of those portions of the Work found not to be in compliance with the Contract Documents by the Owner's Representative and the Owner and forward a copy of the list to the Owner.
   4. Correct the Work to comply with the Contract Documents to the satisfaction of the Owner's Representative and the Owner.
   5. The Contractor shall endeavor to correct the Work before the end of the one-year correction period. Where corrective Work cannot be completed in this time
      a. period, the Contractor shall be required to complete corrections within a reasonable time after the end of the one-year correction period.

B. The Contractor shall not be responsible for correction of Work which has been damaged because of neglect or abuse by the Owner nor shall the Contractor be responsible for the replacement of parts necessitated by normal wear in use.

1.07 PROJECT RECORD DOCUMENTS

A. General: Do not use Project Record Documents for construction purposes. Protect Pro-ject Record Documents from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

B. Record Drawings (As Built-Drawings): Maintain and submit one electronic copy in PDF format of Contract Drawings and Shop Drawings.
   1. Mark Record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to pre-pare the marked-up Record Prints.
      a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later.
      b. Accurately record information in an understandable drawing technique.
      c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
      d. Subject to Architect's approval, mark Contract Drawings showing actual physical conditions, completely and accurately.
      e. Each sheet of the prints shall be certified as to correctness by the Contractor, and where any major portion of the Work is performed by a Subcontractor, the tracings reflecting said subcontract Work shall be properly countersigned by the Subcontractor. Certify record drawing prints as follows:
         1) CERTIFIED CORRECT (3/8-inch high letters) (Name of Subcontractor)
         2) By:
         3) Date:
      f. After all corrections, changes and deviations have been transferred to the prints, the Contractor shall submit the prints to the Architect for review and comments. If additional information is required, or if the drawings are incomplete, the Architect will return the prints to the Contractor for required action. If the record drawings are

complete, the Contractor shall, upon notice by the Architect, submit the record drawing prints to the Architect for delivery to the Owner.

2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
3. Mark important additional information that was either shown schematically or omitted from original Drawings.
4. Note Construction Change Directive numbers, Change Order numbers, alternate numbers, and similar identification where applicable.
5. Identify and date each Record Drawing; include the designation PROJECT RECORD DRAWING in a prominent location. Organize into manageable sets; bind each set with durable paper cover sheets. Include identification on cover sheets.

C. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Mark copy to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Note related Change Orders, Record Drawings, and Product Data, where applicable.

D. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1.08 OPERATION AND MAINTENANCE MANUALS

A. Assemble a complete set of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:
1. Operation Data:
a. Emergency instructions and procedures.
b. System, subsystem, and equipment descriptions, including operating standards.
c. Operating procedures, including startup, shutdown, seasonal, and weekend operations.
d. Description of controls and sequence of operations.
e. Piping diagrams.
2. Maintenance Data:
a. Manufacturer's information, including list of spare parts.
b. Name, address, and telephone number of Installer or supplier.
c. Maintenance procedures.
d. Maintenance and service schedules for preventive and routine maintenance.
e. Maintenance record forms.
f. Sources of spare parts and maintenance materials.
g. Copies of maintenance service agreements.
h. Copies of warranties and bonds.

B. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title OPERATION AND MAINTENANCE MANUAL, Project name, and subject matter of contents.

1.09 WARRANTIES

A. General:

1. All Work shall be warranted for one (1) year, except where longer warranties are specified in the individual specification sections. All warranties shall start from date of Substantial Completion as determined by the Architect.
2. Execute warranties required by the Contract Documents in the Owner's name.
3. Warranties for materials, appliances, and equipment furnished by others and incorporated in the Work must be transferable/assignable to the Owner in such manner that warranty provisions will be enforceable by the Owner.
4. Prior to making application for final payment, collect and deliver all required warranties to the Architect for review and transmittal to the Owner.

B. Submittal Time: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.

C. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

D. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title WARRANTIES, Project name, and name of Contractor.

E. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3- EXECUTION

3.01 DEMONSTRATION AND TRAINING

A. Instruction: Instruct Owner's personnel to adjust, operate, and maintain systems, subsys-tems, and equipment not part of a system.
1. Provide instructors experienced in operation and maintenance procedures.
2. Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.
4. Coordinate instructors, including providing notification of dates, times, length of instruction, and course content.

B. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections. For each training module, develop a learning objective and teaching outline. Submit video of each training module to Owner for future training of Owner’s personnel. Include instruction for the following:
1. System design and operational philosophy.
2. Review of documentation.

3. Operations.
4. Adjustments.
5. Troubleshooting.
6. Maintenance.
7. Repair.

3.02 FINAL CLEANING

A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and anti-pollution regulations.

B. Cleaning:
   1. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instruc-tions.
   2. Complete the following cleaning operations before requesting inspection for cer-tification of Substantial Completion for entire Project or for a portion of Project:
      a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
      b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
      c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
      d. Remove tools, construction equipment, machinery, and surplus material from Project site.
      e. Remove snow and ice to provide safe access to building.
      f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
      g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
      h. Sweep concrete floors broom clean in unoccupied spaces.
      i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
      j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
      k. Remove labels that are not permanent.
         1) Do not remove UL and similar labels, including mechanical and electrical nameplates.
      l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
         1) Do not paint over UL and similar labels, including mechanical and electrical nameplates.
      m. Wipe surfaces of mechanical and electrical equipment, elevator equipment, where applicable and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
      n. Replace parts subject to unusual operating conditions.
      o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
      p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

q. Clean ducts, blowers, and coils if units were operated without filters during construction.
r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
s. Leave Project clean and ready for occupancy.
t. Change all air conditioning filters and permit Owner or his representative to inspect.

C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare a report.

D. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
   1. Operation and maintenance documentation directory.
   2. Emergency manuals.
   3. Operation manuals for systems, subsystems, and equipment.
   4. Maintenance manuals for the care and maintenance of:
      a. Products, materials, and finishes.
      b. Systems and equipment.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.
   1. Related Sections include:
      a. Division 01 Section “Submittal Procedures” for submitting copies of submittals for operation and maintenance manuals.
      b. Division 01 Section “Closeout Procedures” for submitting operation and maintenance manuals.
      c. Division 01 Section “Project Record Documents” for preparing Record Drawings for operation and maintenance manuals.
      d. Divisions 02 through 48 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.03 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.04 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures".

B. Initial Submittal: Submit two (2) draft copies of each manual at least 15 days before requesting inspection for Substantial Completion. Include a complete operation and maintenance directory. Architect will return one (1) copy of draft and mark whether general scope and content of manual are acceptable.

C. Final Submittal: Submit one (1) copy of each manual in final form at least 15 days before final inspection. Architect will return copy with comments within 15 days after final inspection.
   1. Correct or modify each manual to comply with Architect's comments. Submit three (3) copies of each corrected manual within 15 days of receipt of Architect's comments.

1.05 COORDINATION

A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 - PRODUCTS

2.01 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Organization: Include a section in the directory for each of the following:
   1. List of documents.
   2. List of systems.
   3. List of equipment.
   4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, “Preparation of Operating and Maintenance Documentation for Building Systems”.

2.02 MANUALS, GENERAL

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
   1. Title page.
   2. Table of contents.
   3. Manual contents.

B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
   1. Subject matter included in manual.
   2. Name and address of Project.
   3. Name and address of Owner.
   4. Date of submittal.
   5. Name, address, and telephone number of Contractor.
   6. Name and address of Architect.
   7. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
   1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
   1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
      a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.

b. Identify each binder on front and spine, with printed title “OPERATION AND MAINTENANCE MANUAL,” Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
    1) Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
    2) Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes or CDs for computerized electronic equipment.
    3) Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
    4) Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
c. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
d. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.03 EMERGENCY MANUALS

A. Content: Organize manual into a separate section for each of the following:
    1. Type of emergency.
    2. Emergency instructions.
    3. Emergency procedures.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
    1. Fire.
    2. Flood.
    3. Gas leak.
    4. Water leak.
    5. Power failure.
    6. Water outage.
    7. System, subsystem, or equipment failure.
    8. Chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: Include the following, as applicable:
    1. Instructions on stopping.
    2. Shutdown instructions for each type of emergency.
    3. Operating instructions for conditions outside normal operating limits.
    4. Required sequences for electric or electronic systems.
    5. Special operating instructions and procedures.

2.04 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
    1. System, subsystem, and equipment descriptions.
    2. Performance and design criteria if Contractor is delegated design responsibility.
    3. Operating standards.
    4. Operating procedures.
    5. Operating logs.

6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:
1. Product name and model number.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.05 PRODUCT MAINTENANCE MANUAL

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Product Information: Include the following, as applicable:
1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

2.06 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
   1. Standard printed maintenance instructions and bulletins.
   2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
   3. Identification and nomenclature of parts and components.
   4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
   1. Test and inspection instructions.
   2. Troubleshooting guide.
   3. Precautions against improper maintenance.
   4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   5. Aligning, adjusting, and checking instructions.
   6. Demonstration and training videotape, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
   1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
   2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.01 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.

B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
   1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
   2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

E. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
   1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
   1. Do not use original Project Record Documents as part of operation and maintenance manuals.
   2. Comply with requirements of newly prepared Record Drawings in Division 01 Section “Project Record Documents”.

G. Comply with Division 01 Section “Closeout Procedures” for schedule for submitting operation and maintenance documentation.

END OF SECTION

SECTION 01 78 39
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for Project Record Documents, including the following:
   1. Record Drawings.
   2. Record Specifications.
   3. Record Product Data.

B. Related Sections: Work of all sections, including Division 01 Sections, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures".

B. Record Drawings: Comply with the following:
   1. Number of Copies: Submit one (1) set of marked-up Record Prints.

C. Record Specifications: Submit one (1) copy of Project Specifications, including addenda and contract modifications.

D. Record Product Data: Submit one (1) copy of each Product Data submittal.
   1. Where Record Product Data is required as part of operation and maintenance manuals, submit marked-up Product Data as an insert in manual instead of submittal as Record Product Data.

PART 2 - PRODUCTS

2.01 RECORD DRAWINGS

A. Record Prints: Maintain one (1) set of black-line prints of the Contract Drawings and Shop Drawings.
   1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who
      a. obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
         1) Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
         2) Accurately record information in an understandable drawing technique.
         3) Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
   2. Content: Types of items requiring marking include, but are not limited to, the following:
         1) Dimensional changes to Drawings.
         2) Revisions to details shown on Drawings.
         3) Depths of foundations below first floor.
         4) Locations and depths of underground utilities.
         5) Revisions to routing of piping and conduits.
         6) Revisions to electrical circuitry.
         7) Actual equipment locations.
         8) Duct size and routing.

9) Locations of concealed internal utilities.
10) Changes made by Change Order or Change Directive.
11) Changes made following Architect's written orders.
12) Details not on the original Contract Drawings.
13) Field records for variable and concealed conditions.
14) Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Record Transparencies: Immediately before inspection for Certificate of Substantial Completion, review marked-up Record Prints with Architect. When authorized, prepare a full set of corrected transparencies of the Contract Drawings and Shop Drawings.
1. Incorporate changes and additional information previously marked on Record Prints. Erase, redraw, and add details and notations where applicable.
2. Refer instances of uncertainty to Architect for resolution.
3. Print the Contract Drawings and Shop Drawings for use as Record Transparencies. Architect will make the Contract Drawings available to Contractor's print shop.

C. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing Record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
2. Consult Architect for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared Record Drawings into Record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.

D. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Record Transparencies: Organize into unbound sets matching Record Prints. Place transparencies in durable tube-type drawing containers with end caps. Mark end cap of each container with identification. If container does not include a complete set, identify Drawings included.
3. Identification: As follows:
1) Project name.
2) Date.
3) Designation "PROJECT RECORD DRAWINGS".
4) Name of Architect.
5) Name of Contractor.

2.02 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
5. Note related Change Orders, Record Product Data, and Record Drawings where applicable.

2.03 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
   1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

B. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.

C. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

2.04 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

PART 3 - EXECUTION

3.01 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

END OF SECTION

SECTION 01 79 00
DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Harris County's General Conditions for Building Construction and Related Work, Facilities & Property Management Facility Standards, and Contract Documents apply to work of this Section.

1.02 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
   1. Demonstration of operation of systems, subsystems, and equipment.
   2. Training in operation and maintenance of systems, subsystems, and equipment.

B. Related Sections: Work of all sections, including Division 01 Sections and Drawings, as required to properly execute the work and as necessary to maintain satisfactory progress of the work.

1.03 CLOSEOUT SUBMITTALS

A. At completion of training, submit complete training manual(s) for Owner's use.

1.04 QUALITY ASSURANCE

A. This Section outlines only minimum standards and requirements. Refer to the Drawings and other sections of the specifications for additional requirements. Bring all conflicts and discrepancies to the attention of the Architect and appropriate Consultants, and do not start work until such conflicts and discrepancies are clarified and corrected.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements", experienced in operation, maintenance procedures, and training.

PART 2 - PRODUCTS

2.01 INSTRUCTION PROGRAM

A. Training: Include instruction for the following as applicable to the system, equipment, or component:
   1. Documentation: Review the following items in detail:
      a. Emergency manuals.
      b. Operations manuals.
      c. Maintenance manuals.
      d. Project record documents.
      e. Identification systems.
      f. Warranties and bonds.
      g. Maintenance service agreements and similar continuing commitments.

B. Emergencies: Include the following, as applicable:
   1. Instructions on meaning of warnings, trouble indications, and error messages.
   2. Instructions on stopping.
   3. Shutdown instructions for each type of emergency.
   4. Operating instructions for conditions outside of normal operating limits.
   5. Sequences for electric or electronic systems.
   6. Special operating instructions and procedures.

C. Operations: Include the following, as applicable:
   1. Startup procedures.
   2. Equipment or system break-in procedures.

3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Control sequences.
6. Safety procedures.
7. Instructions on stopping.
8. Normal shutdown instructions.
9. Operating procedures for emergencies.
10. Operating procedures for system, subsystem, or equipment failure.
11. Seasonal and weekend operating instructions.
12. Required sequences for electric or electronic systems.
13. Special operating instructions and procedures.

D. Adjustments: Include the following:
1. Alignments.
2. Checking adjustments.
3. Noise and vibration adjustments.
4. Economy and efficiency adjustments.

E. Troubleshooting: Include the following:
1. Diagnostic instructions.
2. Test and inspection procedures.

F. Maintenance: Include the following:
1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Procedures for routine cleaning
5. Procedures for preventive maintenance.
6. Procedures for routine maintenance.
7. Instruction on use of special tools.

G. Repairs: Include the following:
1. Diagnosis instructions.
2. Repair instructions.
3. Disassembly; component removal, repair, and replacement; and reassembly instructions.
4. Instructions for identifying parts and components.
5. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.01 PREPARATION

A. Assemble all information into a manual organized in coordination with requirements in Division 01 Section "Operations and Maintenance Data".

3.02 INSTRUCTION

A. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season. Schedule training with Owner.

END OF SECTION

SECTION 02 41 17
DEMOLITION

PART 1 – GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for demolition of facilities and structures.

B. Extent of demolition work is shown on Drawings. Demolition may, but not necessarily, require removal and disposal, off the Work Site, of the following:

1. Building structures, as indicated on Drawings, except items to be removed by OWNER prior to start of work.
2. Entrances, drives, parking lots and structures, and adjacent landscape work to limits indicated on Drawings.
3. Building foundations and supporting walls to a uniform depth of 12 inches below lowest foundation elevation.
4. Paving, curbs, gutters, walkways, and related concrete and asphalt.

1.02 SUBMITTALS

A. In accordance with Section 01340 - Shop Drawings, Product Data, Samples, and Record Documents of these Specifications, the following shall be submitted:

1. Proposed methods and operations of building demo to OWNER for review and approval prior to start of Work. Include required coordination by agencies for shut-off, capping, and continuation of utility services as required. Provide a detailed sequence of demolition and removal work to ensure uninterrupted progress of OWNER operations.

1.03 QUALITY ASSURANCE/JOB CONDITIONS

A. Reference Standards Applicable to this Section

1. ANSI: American National Standards Institute
   a. A10.6 Safety Requirements for Demolition Operations
2. NFPA: National Fire Protection Association.
   a. 30: Flammable and Combustible Liquids Code
   b. 241: Standard for Safeguarding Building Construction and Demolition Operations.

B. Regulations

Comply with applicable OSHA and EPA regulations and codes and local ordinances.

C. Occupancy

Structures to be demolished will be discontinued in use prior to start of Work.

D. Condition of Structures and Work Site

Owner assumes no responsibility for actual condition of structures to be demolished. Conditions existing at time of inspection for bidding purposes will be maintained by Owner insofar as practicable. However, variations within structure and Work Site may occur prior to start of demolition work.

E. Partial Removal

Items of value to Contractor maybe removed, as directed, as Work progresses. Salvaged items shall become the property of the Contractor and shall be transported from Site as they are removed. Storage or sale of removed items on-Site will not be permitted.

F. Explosives

Use of explosives will not be permitted.

G. Traffic

Contractor shall comply with Section 01570 - Traffic Regulation of these Specifications. Conduct demolition operations and removal of debris to ensure minimum interference with OWNER operations, roads, streets, walks, and adjacent facilities. Do not close or obstruct streets, walks or other facilities without written permission from authorities having jurisdiction. Provide and identify alternate routes around closed or obstructed traffic ways as required by governing regulations.

H. Protection

Contractor shall comply with Section 01510 - Temporary Facilities of these Specifications. Ensure safe passage of persons around area of demolition. Conduct operations to prevent injury to persons and adjacent buildings, structures, and facilities. Erect temporary covered passageways as required by authorities having jurisdiction. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement or collapse of structures to be demolished and adjacent facilities to remain.

I. Damages

Promptly repair damages caused by demolition operations at no cost to Owner or adjacent property owners.

J. Utility Services

Contractor shall comply with Section 01541 - Maintenance and Protection of Utilities of these Specifications. Maintain existing utilities indicated to remain, keep in like service, and protect against damage during demolition operations. Do not interrupt existing utilities serving facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary service during interruptions to existing utilities, as acceptable to governing authorities. Contractor shall disconnect and seal utilities serving structures to be demolished, prior to start of demolition work, upon written direction of OWNER and utility owner.

PART 2 - PRODUCTS (Not used)

PART 3 – EXECUTION

3.01 DEMOLITION

A. GeneralContractor shall comply with NFPA 241 and ANSI A 10.6 prior to and during commencement of demolition.
B. Pollution Control
C. Contractor shall comply with Section 01560 - Environmental Impact Controls of these Specifcations. Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practical level. Comply with governing EPA, OSHA, and local regulations pertaining to environmental protection. Do not create hazardous or objectionable conditions such as flooding and water pollution. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations, as directed by governing authorities. Return adjacent areas to condition existing prior to start of Work.
D. Building Demolition
   Demolish building and structures completely and remove from Work Site. Use such methods as required to complete Work within limitations of governing regulations.

   1. Proceed with demolition in systematic manner, from top of structure to ground.

2. Demolish concrete and masonry in small sections.

3. Break up and remove concrete and asphalt slabs-on-grade, unless otherwise shown to remain.

E. Below-Grade Construction
Demolish foundation walls to a depth of not less than 12 inches below subgrade or lowest foundation element. Demolish and remove below-grade wood, metal construction, floor construction, and concrete and asphalt slabs.

F. Filling Voids

1. Completely fill below-grade areas and voids resulting from demolition. Coordinate with work of Sections 02110 - Site Clearing, and 02200 - Earthwork of these Specifications.

2. Use satisfactory soil materials consisting of stone, gravel, and sand, free from debris, trash, frozen materials, roots and other organic matter.

3. Prior to placement of fill materials, ensure that areas to be filled are free of standing water, frost, frozen material, trash and debris.

4. Place fill materials in horizontal layers not exceeding 8 inches in loose depth. Compact each layer at optimum moisture content of fill material to a density as specified in Section 02200 - Earthwork of these Specifications.
5. After fill placement and compaction as specified, grade surface to meet adjacent contours and to provide flow to surface drainage structures.

3.02 DISPOSAL OF DEMOLISHED MATERIALS

A. General
Remove from Work Site debris, rubbish, and other materials resulting from demolition operations. Burning of removed materials from demolished structures will not be permitted on Site.

B. Removal

Safely transport demolished materials and dispose of legally off Site. Contractor shall comply with NFPA 241, ANSI A 10.6, and NFPA 30, as applicable to the Work of disposal and transport.

END OF SECTION 02 41 17

SECTION 03 05 80
UNDER-SLAB VAPOR BARRIER/RETARDER

PART 1 - GENERAL

1.1 SUMMARY

A. Products Supplied Under This Section
   1. Vapor Barrier, seam tape, mastic, pipe boots, detail strip for installation under concrete slabs.

B. RELATED SECTIONS
   1. Section 03 30 00 Cast-in-place Structural Concrete
   2. Section 01 45 23 Structural Testing and Inspection

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. ASTM E 1745-97 (2004) Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs
   2. ASTM E 154-88 (2005) Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs
   3. ASTM E 96-95 Standard Test Methods for Water Vapor Transmission of Materials
   4. ASTM E 1643-98 (2005) Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs

B. American Concrete Institute (ACI)
   1. ACI 302.2R-06 Vapor Barrier Component (plastic membrane) is not less than 10 mils thick.

1.3 SUBMITTALS

A. Quality Control / Assurance
   1. Full set of test results as per paragraph 8.3 of ASTM E 1745.
   2. Manufacturer’s samples, literature
   3. Manufacturer’s installation instructions for placement, seaming and pipe boot installation.

1.4 SUBSTITUTIONS

A. Product Review
   1. Request must be made 14 days prior to bid date to allow time for proper review. Reviews will be at contractor’s expense.
   2. Independent laboratory test results showing compliance with ASTM E 1745 Class A, a permeance less than 0.01 Perms (grains/(ft2 *hr * in. Hg) before and after the mandatory conditioning tests ASTM E 154 Sections 8,11,12, and 13. (Woven, and recycled plastics are not permitted

3. Incomplete substitutions will not be accepted.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Vapor Barrier (Performance based specification). When the specifications of different sections conflict, the contractor shall perform to the most restrictive provision. Vapor Barrier membrane must have the following properties.
   1. Permeance as tested after mandatory conditioning (ASTM E 154 sections 8,11,12,13) less than 0.01 Perms [grains/(ft2 *hr * in.Hg)]
   2. Other performance criteria
      a. Strength: ASTM E 1745 Class A
      b. Thickness: 15 mils minimum

2.2 ACCESSORIES

A. Seam Tape
   1. Tape must have the following qualities:
      a. Water Vapor Transmission Rate ASTM E 96, 0.3 perms or lower
   2. Seam Tape
      a. Manufacturer’s standard seam tape.
      b. Stego Crete Claw (for slabs on void boxes).

B. Vapor Proofing Mastic
   1. Mastic must have the following qualities:
      a. Water Vapor Transmission Rate ASTM E 96 0.3 perms or lower

C. Pipe Boots
   1. Construct pipe boots from vapor barrier material, pressure sensitive tape and/or mastic per manufacturer’s instructions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ensure that subsoil is approved by architect or geotechnical firm
   1. Level and tamp or roll aggregate, sand or tamped earth base.

3.2 INSTALLATION

A. Install Vapor Barrier/Retarder:
   1. Installation shall be in accordance with manufacturer’s written instructions and ASTM E 1643-09.
      a. Unroll Vapor Barrier/Retarder with the longest dimension parallel with the direction of the pour.
      b. Lap Vapor Barrier/Retarder over footings or seal to foundation walls.

c. Overlap joints 6 inches and seal with manufacturer's tape.
d. Seal all penetrations (including pipes) per manufacturer's instructions.
e. No penetration of the Vapor Barrier/Retarder is allowed except for reinforcing steel and permanent utilities.
f. Repair damaged areas by cutting patches of Vapor Barrier/Retarder, overlapping damaged area 6 inches and taping all four sides with tape.

END OF SECTION 03 05 80

SECTION 03 10 00

CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete formwork, for the following:

1. Footings and/or piers.
2. Foundation walls.
3. Slabs-on-grade.
4. Concrete toppings.

B. Related Sections:

1. Section 01 45 23 “Testing and Inspection Services”.
2. Section 03 30 00 “Cast In Place Concrete”.
3. Section 03 20 00 “Concrete Reinforcing”.

1.3 REFERENCES

A. The latest adopted edition of all standards referenced in this section shall apply, unless noted otherwise.
1. American Concrete Institute (ACI):
a. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials
b. ACI 301 – Specifications for Structural Concrete for Buildings
c. ACI 318 – Building Code Requirements for Structural Concrete
d. ACI 347 – Guide to Formwork for Concrete
e. ACI SP-4 – Formwork for Concrete.

1.4 PERFORMANCE REQUIREMENTS

A. Design and engineering of formwork, including shores, reshores, false work, bracing, and other temporary supports as well as determining when temporary supports and bracing can safely be removed after the specified curing time is the Contractor’s responsibility.

B. All components of the formwork shall be designed to support all loads imposed during construction including weight of construction equipment, live loads, and lateral loads due to wind and imbalance or discontinuity of building components.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

C. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork. Shop drawings for layout of pan type forms, if they exist on the project. Layout only - information and details about the support of these forms is not required, as it is the responsibility of the Contractor and his registered engineer

   1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

D. Manufacturer's product data and installation instruction for propriety materials used in exposed concrete work including form liners, release agents, form systems, ties, and accessories.

E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
   1. Location of construction joints is subject to approval of the Architect.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver form materials in manufacturer's packaging with installation instructions.

B. Store off ground in ventilated and protected area to prevent deterioration from moisture or damage.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician. An experienced installer who has completed work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in service performance.

B. Testing Agency Qualifications: Refer Section 01 45 23.

C. Layout and measurement of concrete forms and embedment's, required for work, performed by a licensed surveyor employed by the contractor.

D. Design, engineering and construction, and removal of formwork are the responsibility of the contractor.

E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
   1. ACI 301, "Specifications for Structural Concrete."
   2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

F. Preinstallation Conference: Conduct conference at Project site.
1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete subcontractor.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

a. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Permanent Metal Forms for Slabs: Deck material, gauge and rib pattern shall be as noted on Drawings.

E. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
1. Pans shall be free of dents, irregularities, sag, rust or other deterioration.
2. In areas permanently exposed to view, provide one piece units, manufactured to length between beams or ribs, or segmented units with reinforced butt-joint splices.

F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

H. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

I. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive damp proofing or waterproofing.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. Class B, 1/4 inch
3. Class C, 1/2 inch
4. Class D, 1 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Coordinate work of other Sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts that are attached to the formwork.
   1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

   2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
   3. Install dovetail anchor slots in concrete structures as indicated.
   4. Install accessories in accordance with manufacturer’s instructions, level and plumb. Ensure items are not disturbed during concrete placement.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.

   1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
   2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
   3. Determine compressive strength of in place concrete by testing representative field-cured test specimens according to ACI 301.

B. Obtaining concrete compressive strength tests for the purposes of form removal shall be the responsibility of the Contractor.

C. In the absence of cylinder tests, formwork shall remain in place until the concrete has cured at a temperature of at least 50 degrees Fahrenheit (10 degrees Celsius) for the minimum cumulative time periods given in ACI 347, Section 3.7.2.3. When the surrounding air temperature is below 50 degrees Fahrenheit (10 degrees Celsius), that time period shall be added to the minimum listed time period.

D. Formwork for two-way conventionally reinforced slabs shall remain in place for at least the minimum cumulative time periods specified for one-way slabs of the same maximum span. Two-way conventionally reinforced slabs shall then be reshored until they attain the specified 28 day strength.

E. Minimum cumulative curing times may be reduced by the use of high-early strength cement or forming systems that allow form removal without displacing shores. However, the Contractor must demonstrate, to the satisfaction of the Architect, that the early removal of forms will not result in excessive sag, distortion or damage to the concrete elements.

F. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

G. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 REUSE OF FORMS

A. Clean and repair surfaces of forms to be used in the Work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form release agent.

B. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
   1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
   2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
   3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
   4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
   5. Space vertical joints in walls as indicated. Otherwise, locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
   6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
   2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants are to be installed.
   3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.6 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

   1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.7 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
   1. Apply scratch finish to surfaces indicated or to receive concrete floor toppings or to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
   1. Apply float finish to surfaces indicated or to receive trowel finish or to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

3.8 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment

END OF SECTION 03 10 00

SECTION 03 20 00
CONCRETE REINFORCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete reinforcement, for the following:

1. Footings and/or piers.
2. Foundation walls.
3. Slabs-on-grade.
4. Concrete toppings.

B. Related Sections:

1. Section 01 45 23 “Testing and Inspection Services”.
2. Section 03 10 00 “Concrete Forming and Accessories”.
3. Section 03 30 00 “Cast In Place Concrete”.
4. Section 04 22 00 “Concrete Unit Masonry”.
5. Section 31 20 00 "Earth Moving".
6. Section 31 63 29 "Drilled Concrete Piers and Shafts".

1.3 REFERENCES

A. The latest adopted edition of all standards referenced in this section shall apply, unless noted otherwise.
1. American Concrete Institute (ACI)
    a. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials.
    b. ACI 301 – Specifications for Structural Concrete for Buildings
    c. ACI 315 – Details and Detailing of Concrete Reinforcement
    d. SP-66 ACI Detailing Manual
2. American Welding Society (AWS)
    a. AWS D1.1 – Structural Welding Code
3. Concrete Reinforcing Steel Institute (CRSI)
    a. CRSI – Manual of Standard Practice
    b. CRSI 63 – Recommended Practice for Placing Reinforcing Bars
    c. CRSI 65 – Recommended Practice for Placing Bar Supports, Specifications and Nomenclature.

B. American Society of Testing Materials (ASTM)
    a. ASTM-A185: Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete Reinforcement.
    b. ASTM-A663: Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.

c. ASTM-A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
d. ASTM-A675: Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.
e. ASTM-A706: Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
f. ASTM-A775: Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
g. ASTM-A884: Standard Specification for Epoxy-Coated Wire and Welded Wire Reinforcement.

C. In the case of conflict between the Contract Documents and a reference standard, the Contract Documents shall govern. In the case of a conflict between the Contract Documents and the Building Code, the more stringent shall govern.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement, according to ACI 315 “Details and Detailing of Concrete Reinforcement.”
1. Do not reproduce the structural drawings for use as shop drawings.

D. Bar Supports: Submit manufacturer’s product information for bolsters, chairs, spaces, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency, installer, and fabricator as indicated herein.

B. Welding certificates.

C. Material Certificates: For each of the following, signed by manufacturers:
1. Steel reinforcement and accessories.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Refer Section 01 45 23.

B. Installer Qualifications: An experienced installer who has completed reinforcing installation work similar in material, design, and extent to that indicated for this Project

and whose work has resulted in construction with a record of successful in service performance.

C. Fabricator Qualifications: An experienced fabricator who has completed reinforcing fabrication work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in service performance.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code - Reinforcing Steel."

E. Preinstallation Conference: Conduct conference at Project site.
1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Concrete subcontractor.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings, if any, on steel reinforcement.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615, Grade 60 for #6 and smaller bars, Grade 75 for #7 and larger bars, deformed.

C. Low-Alloy-Steel Reinforcing Bars for bars to be welded: ASTM A 706, Grade 60 for #6 and smaller bars, Grade 75 for #7 and larger bars, deformed.

D. Stainless-Steel Reinforcing Bars: ASTM A 955, Grade 60, [Type 304] [Type 316L], deformed.

E. Steel Bar Mats: ASTM A 184, fabricated from ASTM A 615, Grade 60 or ASTM A 706, deformed bars, assembled with clips.

F. Plain-Steel Wire: ASTM A 82, as drawn .

G. Deformed-Steel Wire: ASTM A 496.

H. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

I. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

2.2 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. Use wire bar type supports complying with CRSI recommendations, unless otherwise indicated. Do not use wood, brick, or other unacceptable materials.

2.3 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice." Combined tolerances for formwork, reinforcing fabrication, and reinforcing placement shall not permit a reduction in specified concrete cover of reinforcing steel. In case of fabricating errors, do not re-bend or straighten reinforcement in a manner that will injure or weaken material. Bars used for concrete reinforcement shall meet following requirements for fabricating tolerances:
1. Sheared length: Plus or minus 1 inch.
2. Depth of truss bars: Plus 0, minus ½ inch.
3. Overall dimensions of stirrups, ties, and spirals: Plus or minus ½ inch.
4. Other bends: Plus or minus 1 inch.

B. For bars with end bearing splice couplers, bar ends shall terminate in flat surfaces, within 1.5 degrees of a right angle to axis of bars and shall be fitted within 3 degrees of full bearing after assembly.

2.4 DOWEL BAR ANCHORS/SPLICERS

A. A. Provide dowel bar anchors and threaded dowels designed to develop, both in tension and compression, 125% of the minimum ASTM specified yield strength of the dowel bars, as evidenced by published I.C.B.O. test reports. Unless otherwise indicated, anchors shall be furnished with ACI standard 90 degree hooks. Dowels shall be furnished by anchor supplier. The following dowel splicing systems are acceptable.
1. Richmond Screw Anchor “Dowel Bar Splicer”
2. Erico “Lenton Form Saver”
3. Dayton Barsplice “Grip-Twist”

2.5 MECHANICAL SPLICES

A. A. Provide mechanical splices designed to develop, both in tension and compression, 125% of minimum ASTM yield strength of the smaller bar being coupled, as evidenced by published I.C.B.O test reports. The following bar splicing systems are acceptable.
1. Erico “Cadweld C-Series”
2. Erico “Lenton”

3. Dayton Barsplice “Bar Grip”
4. Dayton Barsplice “Grip Twist”

2.6 METAL ANCHORAGE AND EMBEDDED METAL ASSEMBLIES

A. Steel Shapes and Plates: Conform to ASTM A36, “Specification for Structural Steel”.

B. Headed Stud Anchors: Headed studs welded by full fusion process, as furnished by TRW Nelson Stud Welding Division.

C. Welding Electrodes: AWS 5.5, Series E70.

D. Welded Deformed Bar Anchors: Welded by full fusion process, as furnished by TRW Nelson Stud Welding Division.

E. All metal assemblies exposed to earth, weather or moisture, including exposure to a crawl space environment, shall be hot dip galvanized.

2.7 FABRICATION OF METAL ACCESSORIES AND EMBEDDED METAL ASSEMBLIES

A. Fabricate and assemble structural steel items in the shop. Shearing, flame cutting, and chipping shall be done carefully and accurately. Holes shall be cut, drilled, or punched at right angles to the surface of metal and shall not be made or enlarged by burning. Holes shall be clean-cut without torn or ragged edges. Welded construction shall conform to AISC “Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings,” and AWS D1.1. Welding shall be done by AWS certified welders.

B. Welding of deformed bar anchors and headed stud anchors shall be done by full fusion process equal to that of TRW Nelson Stud Welding Division of KSM Welding Services Division, Omark, Ind. A minimum of two headed studs shall be tested at start of each production period for proper quality control. Studs shall be capable of being bent 45 degrees without weld failure.

C. Welding of reinforcement shall be done in strict accordance with AWS requirements, using recommended preheat temperature and electrode for type of reinforcement being welded. Bars larger than No. 9 shall not be welded. Welding shall be performed subject to the observance and testing laboratory. Under no circumstances is ordinary reinforcing (ASTM A615) to be welded.

D. Coatings, where required, shall be applied after fabrication and prior to casting concrete.

PART 3 - EXECUTION

3.1 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated.

3.2 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
   1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

   1. Weld reinforcing bars according to AWS D1.4, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

F. Provide minimum concrete covering for reinforcement as shown in the Structural General Notes.

G. Place bars to following tolerances:
   1. Clear distance to formed surfaces: Plus or minus ¼ inch.
   2. Minimum spacing between bars: Minus ¼ inch.
   3. Top bars in slabs and beams:
      a. Members 8 inches deep or less: Plus or minus ¼ inch.
      b. Members between 8 and 24 inches deep: Plus or minus ½ inch.
      c. Members more than 24 inches deep: Plus or minus 1 inch.
   4. Crosswise of members: Spaced evenly within 2 inches.
   5. Length of members: Plus or minus 2 inches.

H. Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If moved more than one bar diameter, or enough to exceed above tolerances, resulting arrangement of bars subject to approval.

I. Support reinforcement and fasten together to prevent displacement by construction loads or placing concrete beyond tolerances indicated.

J. Unless permitted by Engineer, do not bend reinforcement after embedding in hardened concrete.

3.3 FIELD QUALITY CONTROL

A. Testing and Inspecting: See Section 01 45 23.

B. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.

END OF SECTION 03 20 00

SECTION 03 21 00
CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Work shall consist of furnishing and placing reinforcing steel in accordance with these Specifications and in conformity with the Drawings.

1.02 RELATED SECTION

A. The following is a list of Specifications which may be related to this section:
   1. Section 03 31 00, Structural Concrete

1.03 REFERENCES

A. American Association of State and Highway Transportation Officials (AASHTO):
   1. M31M/M31, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   2. AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

B. American Concrete Institute (ACI):
   1. ACI Detailing Manual.
   2. 117, Specifications for Tolerance for Concrete Construction and Materials.
   3. 318, Building Code Requirements for Structural Concrete.

C. ASTM International (ASTM):
   1. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   2. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   3. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   4. A996/A996M, Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
   5. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   6. A767/A767M, Standard Specification for Zinc-coated (Galvanized) Steel Bars for Concrete Reinforcement.
   7. A775/A775M, Standard Specification for Epoxy-coated Steel Reinforcing.

D. Concrete Reinforcing Steel Institute (CRSI):
   1. Manual of Standard Practice.
   2. Placing Reinforcing Bars.

1.04 SUBMITTALS

A. Two copies of a list of all reinforcing steel and bending diagrams shall be furnished to the ENGINEER at the site of the work at least one week before the placing of reinforcing steel is begun. Such lists will not be reviewed for accuracy. The CONTRACTOR shall be responsible for the accuracy of the lists and for furnishing and placing all reinforcing steel in accordance with the details shown on the plans.

1.05 DELIVERY, STORAGE, AND PROTECTION

A. Reinforcing steel shall be stored off of the ground and protected from oil or other materials detrimental to the steel or bonding capability of the reinforcing bar. Epoxy coated reinforcing bars shall be stored on protective cribbing.

PART 2 PRODUCTS

2.01 REINFORCING STEEL

A. Deformed Bars: All bar steel reinforcement shall be of the deformed type, ASTM A615, AASHTO M31M/M31, and Grade (40 or 60) as specified on the DRAWINGS. B. Spirals:

1. Spirals, hot-rolled plain or deformed bars per ASTM A615, Grade 60 or cold drawn wire per ASTM A82/A82M as specified on the DRAWINGS.
2. Spirals for columns shall have two (2) “spacers” with a section modulus 0.030in^3 in order to maintain the proper pitch and spacing.

B. Epoxy-Coated Reinforcing Bars: Epoxy-coated reinforcing bars shall conform to ASTM A775/A775M. When required, damaged epoxy coating shall be repaired with patching material conforming to ASTM A775/A775M in accordance with the material manufacturer’s recommendations.

C. Zinc-coated (Galvanized Reinforcing Bars): Zinc-coated reinforcing bars shall conform to ASTM A767/A767M. When required, damaged zinc coating shall be repaired with a zinc-rich formulation conforming to ASTM A767/A767M.

D. Welded Wire Fabric: All welded wire fabric reinforcement shall conform to ASTM A497/A497M. F. Identification:

1. Bundles of reinforcing bars and wire spirals shall be tagged, with a metal tag, showing specification, grade, size, quantity, and suitable identification to permit checking, sorting, and placing. When bar marks are used to identify reinforcing bars on the DRAWINGS, the bar mark shall be shown on the tag. Tags shall be removed prior to concrete placement.

2. Bundles of flat sheets and rolls of welded wire fabric shall be tagged similar to reinforcing bars.

2.02 TIRE WIRE

A. 16-gauge wire ties, manufactured by American Wire Tie, Inc., or equal. When epoxy-coated reinforcing steel is shown on the DRAWINGS, PVC coated wire ties shall be used. The minimum PVC coating shall be 0.7 mils.

2.03 BAR SUPPORT

A. General: Bar supports and spacing shall be in accordance with the CRSI Manual of Standard Practice, Chapter 3, a maximum of four (4) feet, or as required by the Drawings.

B. Floor Slabs: Uncoated steel or non-metallic composite chairs shall be used unless otherwise shown on the DRAWINGS. If required by Engineer, the chair shall be stapled on a bearing pad to prevent chair displacement. The bearing pad shall be made of exterior grade plywood and be approximately five (5) inches square.

C. Columns: Plastic “space wheels” manufactured by Aztec (Model DO 12/40), or equal, are required.

D. Epoxy-Coated and Zinc-Coated Bar Supports: Epoxy-coated reinforcing bars supported from formwork shall rest on coated wire bar supports made of dielectric or other acceptable materials. Wire supports shall be fully coated with dielectric material, compatible with concrete. Reinforcing bars used as support bars shall be epoxy-coated. In walls reinforced with epoxy-coated bars, spreader bars shall be epoxy-coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing shall be made of corrosion-resistant material or coated with dielectric material.

2.04 FABRICATION

A. Fabrication tolerances for straight and bent bars shall be in accordance with the requirements of Subsection 4.3, Tolerance, of ACI 315 and the CRSI Manual of Standard Practice.

PART 3 EXECUTION

3.01 GENERAL

A. Rust, seams, surface irregularities, or mill scale shall not be cause for rejection provided that the weight and height of deformations of a hand-wire-brushed test specimen are not less than the applicable ASTM Specification

3.02 BAR LIST

A. Contractor shall be responsible for the accuracy of the lists and for furnishing and placing all reinforcing steel in accordance with the details shown on the Drawings.

B. Bar lists and bending diagrams for structures, which are included on the Drawings, do not have to be furnished by the Contractor. When bar lists and bending diagrams are included on the Drawings, they are intended for estimating approximate quantities. Contractor shall verify the quantity, size, and shape of the bar reinforcement against those shown on the Drawings and make any necessary corrections before ordering.

3.03 BENDING

A. All reinforcing bars shall be bent cold. Bars partially embedded in concrete shall not be field bent, except as shown on the DRAWINGS or permitted. Bars shall not be bent or straightened in a manner that may injure the material.

3.04 SPIRALS

A. One and one-half (1-1/2) finishing bends are required at the top and bottom of the spiral. Spacers shall be provided in accordance with Chapter 5, Section 9 of the CRSI Manual of Standard Practice. Welding as an aid to fabrication and/or installation is not permitted.

3.05 PLACING AND FASTING

A. When placed in the Work, the reinforcing bars shall be free from dirt, loose mill scale, paint, oil, loose rust, or other foreign substance.

B. The placing, fastening, splicing, and supporting of reinforcing steel and wire mesh or bar mat reinforcement shall be in accordance with the Drawings and the latest edition of “CRSI Placing Reinforcing Bars.” In case of discrepancy between the Drawings and the CRSI publication stated above, the Drawings shall govern. Reinforcement shall be placed within the tolerances provided in ACI 117.

C. Steel reinforcement shall be accurately placed in the positions shown on the

D. Drawings and firmly held during the placing and setting of concrete by means of

E. spacer strips, stays, metal chairs or other approved devices or supports. Precast concrete bricks or other types of bricks are not permitted for support of reinforcement in footings, slabs, or any other part of the work. Chair and bolster supports for slabs and walls shall be spaced at a maximum of four- (4-) foot centers unless otherwise shown on the Drawings. Staples used to attach bar supports to wall and roof forms shall have the staple “tails” clipped after form removal. For columns, three (3) wheels, spaced one hundred twenty degrees (120°) apart, shall be placed every four (4) feet of column height. Contractor may increase the column spiral pitch if a conflict occurs with the wheel. Pre-tied column reinforcing steel lowered into column forms shall be lowered vertically to prevent damage to the space wheels.

F. Bars shall be securely tied at fifty percent (50%) of all intersections except where spacing is less than one (1) foot in each direction, when alternate intersections shall be tied unless otherwise called out on the Drawings or in applicable Specifications. Tying of steel by spot welding

shall not be permitted unless specifically authorized by Engineer. the placing and securing of the reinforcement in any unit or section shall be accepted by Engineer before any concrete is placed in any such unit or section.

G. Bundle bars shall be tied together at not more than six- (6-) foot centers.

3.06 SPLICING

A. Bar steel reinforcement shall be furnished in the full lengths indicated on the Drawings. Splicing of bars, except where shown on the Drawings, shall not be permitted without the written acceptance of Engineer. Splices shall be staggered. In cases where permission is granted to splice bars, other than those shown on the Drawings, the additional material required for the lap shall be furnished by Contractor at Contractor's own expense. The minimum distance between staggered splices for reinforcing bars shall be the length required for a lapped splice in the bar. All splices shall be full contact splices.

B. Splices shall not be permitted at points where the section is not sufficient to provide a minimum distance of two (2) inches between the splice and the nearest adjacent bar or the surface of the concrete.

C. Welding of reinforcement shall be done only if detailed on the Drawings or if authorized by Engineer in writing. Welding shall be done by a certified welder. The welding shall conform to AWS D1.4/D1.4M with the modifications and additions specified hereinafter. Where AWS D2.0 Specifications for Welded Highway and Railway Bridges is referenced, the reference shall be construed to be for AWS D1.1. Where the term AWS D1.1/D1.1M is used it shall mean the American Welding Society Structural Welding Code, D1.5/D1.5M as modified and amended by the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges. After completion of welding, coating damage to coated reinforcing steel bars shall be repaired.

D. When required or permitted, a mechanical connection may be used to splice reinforcing steel bars or as substitution for dowel bars. The mechanical connection shall be capable of developing a minimum of one hundred twenty five percent (125%) of the yield strength of the reinforcing bar in both tension and compression. All parts of mechanical connections used on coated bars, including steel splice sleeves, bolts, and nuts shall be coated with the same material used for repair of coating damage.

3.07 CUTTING

A. When coated reinforcing bars are cut in the field, the ends of the bars shall be coated with the same material used for repair of coating damage.

END OF SECTION 03 21 00

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Foundation walls.
3. Slabs-on-grade.
4. Concrete toppings.

B. Related Sections:

1. Section 01 45 23 “Structural Testing and Inspection Services”.
2. Section 03 20 00 "Concrete Forming and Accessories".
3. Section 03 10 00 "Concrete Reinforcing".
4. Section 03 15 13 “Waterstops”.
5. Section 03 05 80 “Under-slab Vapor Barrier – Retarder”.
6. Section 31 63 29 “Drilled Concrete Piers and Shafts”.

1.3 REFERENCES

A. The latest adopted edition of all standards referenced in this section shall apply, unless noted otherwise.
1. ACI 301 – Specification for Structural Concrete.
2. ACI 302 – Guide for Concrete Floor Slab Construction.
3. ACI 304 – Guide for Measuring, Mixing, Transporting and Placing Concrete.
4. ACI 305 – Hot Weather Concreting.
5. ACI 306 – Cold Weather Concreting.
6. ACI 308 – Guide to Curing Concrete.
7. ACI 309 – Guide for Consolidating Concrete.
8. ACI 311 – ACI Manual for Concrete Inspection.
9. ACI 318 – Building Code Requirements for Reinforced Concrete.
10. ACI 347 – Guide to Concrete Formwork.
11. ACI 207 – Mass Concrete.
12. ACI 211.1 – Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
13. ACI 211.2 – Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
14. ACI 212.3 – Chemical Admixture for Concrete.

15. ACI 212.4 – Guide for the use of High Range Water Reducing Admixtures in Concrete.
16. ACI 214 – Evaluation of Strength Test Results of Concrete.
17. ACI 303 – Guide to Cast in Place Architectural Concrete Practice.
18. Concrete Reinforcing Steel Institute, “Manual of Standard Practice”.

B. In the case of conflict between the Contract Documents and a referenced standard, the Contract Documents shall govern. In the case of a conflict between the Contract Documents and the Building Code, the more stringent shall govern.

1.4 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Data for Credit IEQ 4.3: For liquid floor treatments and curing and sealing compounds, documentation including printed statement of VOC content.

3. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for Portland cement or other Portland cement replacements, and for equivalent concrete mixtures that do not contain Portland cement replacements.

C. Design Mixtures: For each concrete mixture include the following information. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
1. Each proposed mix design shall be accompanied by a complete standard deviation analysis based on at least 30 consecutive strength tests, or by three laboratory trial mixtures with confirmation tests.
2. Proportions of cement, fine, and coarse aggregate, and water.
3. Design strength.
4. Maximum slump.
5. Air Content.
6. Maximum water / cement ratio.
7. Maximum and minimum concrete temperature that is acceptable at time of placement for which the manufacturer can guarantee the strength of the concrete.
8. Type cement and aggregates.
9. Type and quantities of all admixtures.
10. Air dry density and splitting tensile strength for lightweight concrete determined in accordance with ASTM 330.
11. Type, color, and quantities of integral coloring compounds, where applicable.
12. Indicate amounts of mixing water to be withheld for later addition at Project site.

D. Steel Reinforcement Shop Drawings: Refer Section 03 20 00.

E. Formwork Shop Drawings: Refer Section 03 10 00.

F. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
   1. Location of construction joints is subject to approval of the Architect.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Welding certificates.

C. Material Certificates: For each of the following, signed by manufacturers:

   1. Cementitious materials.
   2. Admixtures.
   3. Fiber reinforcement.
   4. Curing compounds.
   5. Floor and slab treatments.
   6. Bonding agents.
   7. Adhesives.
   8. Semi rigid joint filler.
   9. Joint-filler strips.
   10. Repair materials.

D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
   1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

F. Field quality-control reports.

G. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: See Section 01 45 23.

1. Contractor’s responsibility to testing laboratory.
    a. Furnish all labor and materials as required to assist testing agency in obtaining, making and handling samples at the jobsite.
    b. Advise the Owner’s Testing Laboratory sufficiently in advance of operations to allow adequate time for the assignment of testing personnel.
    c. Furnish and maintain adequate facilities for proper curing of concrete test specimens on the project site in accordance with ASTM C31.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code - Reinforcing Steel."

F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301, "Specifications for Structural Concrete."
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

G. Mockups: Cast concrete slab-on-grade and formed-surface panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.

1. Build panel approximately 200 sq. ft. for slab-on-grade and 100 sq. ft. for formed surface in the location indicated or, if not indicated, as directed by Architect.

H. Preinstallation Conference: Conduct conference at Project site.
1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
    a. Contractor's superintendent.
    b. Independent testing agency responsible for concrete design mixtures.
    c. Ready-mix concrete manufacturer.
    d. Concrete subcontractor.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings, if any, on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. See Section 03 10 00.

2.2 STEEL REINFORCEMENT

A. See Section 03 20 00.

2.3 REINFORCEMENT ACCESSORIES

A. See Section 03 20 00.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I or Type I/II, gray. Supplement with the following:
   a. Fly Ash: ASTM C 618, Class F or C. Carbon content shall not exceed 3 percent by volume.
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years of satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
1. Maximum Coarse-Aggregate Size: 1-1/2 inches, 1 inch, or 3/4 inch nominal as indicated on Drawings for specific uses.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Lightweight Aggregate: ASTM C 330, 3/4-inch nominal maximum aggregate size.

D. Water: ASTM C 94 and potable.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that contain not more than 0.05 percent water soluble chloride ions. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494, Type A.
2. Retarding Admixture: ASTM C 494, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

C. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ChemMasters.
b. Davis Colors.
c. Dayton Superior Corporation.
d. Hoover Color Corporation.
e. Lambert Corporation.
f. QC Construction Products.
g. Rockwood Pigments NA, Inc.
h. Scofield, L. M. Company.
i. Solomon Colors, Inc.

2. Color: As selected by Architect from manufacturer's full range.

2.6 FIBER REINFORCEMENT

A. Synthetic Macro-Fiber: Polyolefin macro-fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, 1 to 2-1/4 inches long.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. 3M; Scotchcast Polyolefin Fibers 2".
      b. Euclid Chemical Company (The), an RPM company; Tuf-Strand SF.
      c. FORTA Corporation; FORTA FERRO.
      d. Grace Construction Products, W. R. Grace & Co.; Strux 90/40.
      e. Nycon, Inc.; XL.
      f. Propex Concrete Systems Corp.; Fibermesh 650.
      g. Sika Corporation; Sika Fiber MS or MS10.

2.7 CONCRETE MIX DESIGNS

A. Selection of Proportions: Proportions of ingredients for concrete mixes shall be determined by a qualified concrete supplier in accordance with the requirements of ACI 301.

B. Required average strength above specified strength: Determination of required average strength above specified strength shall be based on the standard deviation record of the production facility in accordance with ACI 301. Calculation of standard deviation of compressive strength results shall be made in accordance with ACI 214. If a suitable record of strength tests is not available, proportions shall be selected on the basis of laboratory trial batches to produce an average strength greater than the strength f'c by the amount defined in ACI 301.

2.8 VAPOR RETARDERS

A. See Section 03 05 80.

2.9 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, non-glazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing No. 8 sieve.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Anti-Hydro International, Inc.; Emery.

b. Dayton Superior Corporation; Emery Tuff Non-Slip.
c. Lambert Corporation; EMAG-20.
d. L&M Construction Chemicals, Inc.; Grip It.
e. Metalcrete Industries; Metco Anti-Skid Aggregate.

B. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Anti-Hydro International, Inc.; A-H Alox.
b. BASF Construction Chemicals - Building Systems; Frictex NS.
c. L&M Construction Chemicals, Inc.; Grip It AO.

2.10 LIQUID FLOOR TREATMENTS

A. VOC Content: Liquid floor treatments shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
1. Products: Subject to compliance with requirements, provide one of the following:
a. ChemMasters; Chemisil Plus.
b. ChemTec Int'l; ChemTec One.
c. Conspec by Dayton Superior; Intraseal.
d. Curecrete Distribution Inc.; Ashford Formula.
e. Dayton Superior Corporation; Day-Chem Sure Hard (J-17).
f. Edoco by Dayton Superior; Titan Hard.
g. Euclid Chemical Company (The), an RPM company; Euco Diamond Hard.
h. Kaufman Products, Inc.; SureHard.
i. L&M Construction Chemicals, Inc.; Seal Hard.
j. Meadows, W. R., Inc.; LIQUI-HARD.
k. Metalcrete Industries; Floorsaver.
l. Nox-Crete Products Group; Duro-Nox.
m. Symons by Dayton Superior; Buff Hard.
n. US SPEC, Division of US Mix Products Company; US SPEC Industraseal.
o. Vexcon Chemicals, Inc.; Vexcon StarSeal PS Clear.

C. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and is suitable for polished concrete surfaces.
1. Products: Subject to compliance with requirements, provide one of the following:

a. Advanced Floor Products; Retro-Plate 99.
b. L&M Construction Chemicals, Inc.; FGS Hardener Plus.
c. QuestMark, a division of CentiMark Corporation; DiamondQuest Densifying Impregnator Application.

2.11 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
1. Products: Subject to compliance with requirements, provide one of the following:

a. Axim Italcementi Group, Inc.; CATEXOL CimFilm.
b. BASF Construction Chemicals - Building Systems; Confilm.
c. ChemMasters; SprayFilm.
d. Conspec by Dayton Superior; Aquafilm.
e. Dayton Superior Corporation; Sure Film (J-74).
f. Edoco by Dayton Superior; BurkeFilm.
g. Euclid Chemical Company (The), an RPM company; Eucobar.
h. Kaufman Products, Inc.; Vapor-Aid.
i. Lambert Corporation; LAMBCO Skin.
j. L&M Construction Chemicals, Inc.; E-CON.
k. Meadows, W. R., Inc.; EVAPRE.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group; MONOFILM.
n. Sika Corporation; SikaFilm.
o. SpecChem, LLC; Spec Film.
p. Symons by Dayton Superior; Finishing Aid.
q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
r. Unitex; PRO-FILM.
s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
b. BASF Construction Chemicals - Building Systems; Kure 200.
c. ChemMasters; Safe-Cure Clear.
d. Conspec by Dayton Superior; W.B. Resin Cure.
e. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
f. Edoco by Dayton Superior; Res X Cure WB.
g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
h. Kaufman Products, Inc.; Thinfilm 420.
i. Lambert Corporation; AQUA KURE - CLEAR.
j. L&M Construction Chemicals, Inc.; L&M Cure R.
k. Meadows, W. R., Inc.; 1100-CLEAR.
l. Nox-Crete Products Group; Resin Cure E.
m. Right Pointe; Clear Water Resin.
n. SpecChem, LLC; Spec Rez Clear.
o. Symons by Dayton Superior; Resi-Chem Clear.
p. TK Products, Division of Sierra Corporation; TK-2519 DC WB.
q. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
1. Products: Subject to compliance with requirements, provide one of the following:
a. BASF Construction Chemicals - Building Systems; Kure 1315.

b. ChemMasters; Polyseal WB.
c. Conspec by Dayton Superior; Sealcure 1315 WB.
d. Edoco by Dayton Superior; Cureseal 1315 WB.
e. Euclid Chemical Company (The), an RPM company; Super Diamond Clear VOX; LusterSeal WB 300.
f. Kaufman Products, Inc.; Sure Cure 25 Emulsion.
g. Lambert Corporation; UV Safe Seal.
h. L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
i. Meadows, W. R., Inc.; Vocomp-30.
j. Metalcrete Industries; Metcure 30.
k. Right Pointe; Right Sheen WB30.
l. Symons by Dayton Superior; Cure & Seal 31 Percent E.
m. Vexcon Chemicals, Inc.; Vexcon Starseal 1315.

2. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.12 RELATED MATERIALS

A. Expansion and Isolation Joint Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

B. Semi-rigid Joint Filler: Two-component, semi-rigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.

C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.13 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
   1. Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
   2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
   4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109.

2.14 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
   1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, as indicated in Structural General Notes.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
   2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
   3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
   4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.15 NON-SHRINK GROUT

A. Grout shall be prepackaged, non metallic, and non gaseous. It shall be non-shrink when tested in accordance with ASTM-C1107 Grade B or C at a fluid consistency (flow cone) of 20 to 30 seconds. Thirty-minute-old grout shall flow through the flow cone after slight agitation, in temperatures of 40 degrees to 90 degrees Fahrenheit. Grout shall be bleed free and attain 7,500 psi compressive strength in 28 days at fluid consistency. Certified independent test data required. Approved products include the following:
   1. “Euco NS” by Euclid Chemical Company
   2. “Masterflow 713” by Master Builders.

2.16 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Proportion normal-weight concrete mixture as indicated in Structural General Notes:

2.17 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.18 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information.
   1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. See Section 03 10 00.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
   2. Install dovetail anchor slots in concrete structures as indicated.

3.3 REMOVING AND REUSING FORMS

A. See Section 03 10 00.

3.4 SHORES AND RESHORES

A. See Section 03 10 00.

3.5 VAPOR RETARDERS/BARRIERS

A. See Section 03 05 80.

3.6 STEEL REINFORCEMENT

A. See Section 03 20 00

3.7 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
   1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
   2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
   3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
   4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
   5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
   6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
   1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
   2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
   2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants are specified or otherwise indicated.
   3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
   1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
   2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
   3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Do not permit concrete to drop freely any distance greater than 10’-0” for concrete containing a high range water reducing admixture or 5’-0” for other concrete. Provide chute or tremie to place concrete where longer drops are necessary. Do not place concrete into excavations with standing water. If place of deposit cannot be pumped dry, pour concrete through a tremie with its outlet near the bottom of the place of deposit.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   2. Maintain reinforcement in position on chairs during concrete placement.
   3. Screed slab surfaces with a straightedge and strike off to correct elevations.
   4. Slope surfaces uniformly to drains where required.
   5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleed water appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

G. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

H. Hot-Weather Placement: Comply with ACI 305 and as follows:
1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.9 FINISHING FORMED SURFACES

A. See Section 03 10 00.

3.10 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
1. Apply scratch finish to surfaces indicated and/or to receive concrete floor toppings or to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces indicated and/or to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
1. Apply a trowel finish to surfaces indicated and/or exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
2. Finish surfaces according to ASTM E 1155, for a randomly trafficked floor surface.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated or where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
   1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

G. Slip-Resistive Finish: Before final floating, apply slip-resistive finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
   1. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistivegranules over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
   2. After broadcasting and tamping, apply float finish.
   3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive granules.

3.11 CONCRETE FLOOR FINISH TOLERANCES

A. Interior Finish Floor surfaces to the following tolerances, measured within 24 hours according to ASTM E 1155, "Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System." The following values apply before removal of shores. Levelness values F(L) do not apply to intentionally sloped or cambered areas, nor to slabs poured on metal deck or precast concrete.
   1. Exposed, vinyl tiled, or thin-set tiled floors: Specified overall values of flatness, Ff =35; and levelness, Fl =25; with minimum local values of flatness, Ff =24; and levelness, Fl =17.
   2. Carpeted floors, floors under concrete toppings, thickset tile and terrazzo: Specified overall values of flatness, Ff =25; and levelness, Fl = 20; with minimum local values of flatness, Ff =17; and levelness, Fl =15.

B. Floor Elevation Tolerance Envelope:
   1. The acceptable tolerance envelope for absolute elevation of any point on the slab surface, with respect to the elevation shown on the Drawings, is as follows:
      a. Slab-on-Grade, or Slab-on-Void Construction: +/- 3/4"
      b. Top surfaces of formed slabs measured prior to removal of supporting shores: +/- 3/4"
      c. Top surfaces of all other slabs: +/- 3/4"
      d. Slabs specified to slope shall have a tolerance from the specified slope of 3/8" in 10'-0" at any point, up to 3/4" from theoretical elevation at any point.

3.12 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at

correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.13 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
    a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing

compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturers written instructions.
   1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
   2. Do not apply to concrete that is less than 28 days' old.
   3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Polished Concrete Floor Treatment: Apply polished concrete finish system to cured and prepared slabs to match accepted mockup.
   1. Machine grind floor surfaces to receive polished finishes level and smooth and to depth required to reveal aggregate to match approved mockup.
   2. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
   3. Continue polishing with progressively finer grit diamond polishing pads to gloss level to match approved mockup.
   4. Control and dispose of waste products produced by grinding and polishing operations.
   5. Neutralize and clean polished floor surfaces.

C. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.15 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
   1. Defer joint filling until concrete has aged at least six month(s). Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semi-rigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.16 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
   2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
   3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   2. After concrete has cured at least 14 days, correct high areas by grinding.
   3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

   4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
   5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
   6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and

mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.17 FIELD QUALITY CONTROL

A. Testing and Inspecting: See Section 01 45 23.
   1. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
   2. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.18 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 03 30 00

SECTION 03 35 11
CONCRETE FLOOR FINISHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete stains and dyes.

B. Clear coatings.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

B. Coordinate the work with concrete floor placement and concrete floor curing.

1.03 SUBMITTALS

A. Product Data: Manufacturer's published data on each finishing product, including information on compatibility of different products and limitations.

B. Maintenance Data: Provide data on maintenance and renewal of applied finishes.

C. Specimen warranty.

D. Executed warranty.

1.04 MOCK-UPS

A. For coatings, construct mock-up area under conditions similar to those that will exist during application, with coatings applied.

B. Locate where directed.

C. Approved mock-up may remain as part of the work.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's sealed packaging, including application instructions.

1.06 FIELD CONDITIONS

A. Maintain light level equivalent to a minimum 200 W light source at 8 feet above the floor surface over each 20 foot square area of floor being finished.

B. Do not finish floors until interior heating system is operational.

C. Maintain ambient temperature of 50 degrees F minimum.

1.07 WARRANTY

A. Finish Warranty: Provide five-year manufacturer warranty against excessive degradation of finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 COATINGS

A. Concrete Stain or Dye: Translucent, penetrating compound for interior or exterior use; finish with topical sealer.
   1. Number of Coats: Minimum of two.
   2. VOC: 100 g/L or less.
   3. Primary Color: As indicated on drawings, in a formulation to match approved mock-up.
   4. Application:
      a. Primary Color: In accordance with manufacturer's written instructions to achieve best results and match approved mock-up.
   5. Composition: Water-based, nonreactive.
      a. Products:
         1) Euclid Chemical Company: www.euclidchemical.com

2) Basis of Design: PROSOCO, Inc; GemTone Stain: www.prosoco.com/consolideck/#sle.
3) SureCrete Design Products: www.surecretedesign.com/#sle.

B. Clear Coatings: Clear coating recommended by manufacturer for finishing concrete floors and slabs.
1. Gloss: Match approved mock-up.
2. Color(s): As selected by Architect from manufacturer's standard range.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that floor surfaces are acceptable to receive the work of this section.

B. Verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes.

3.02 PREPARATION

A. Prepare substrate to receive concrete stain in accordance with manufacturer's written instructions.

3.03 GENERAL

A. Apply materials in accordance with manufacturer's instructions.

3.04 COATING APPLICATION

A. Verify that surface is free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.

B. Verify that water vapor emission from concrete and relative humidity in concrete are within limits established by coating manufacturer.

C. Protect adjacent non-coated areas from drips, overflow, and overspray; immediately remove excess material.

D. Apply coatings in accordance with manufacturer's instructions, matching approved mock-ups for color, special effects, sealing and workmanship.

3.05 CONCRETE POLISHING

A. Execute using materials, equipment, and procedures specified by manufacturer, using manufacturer approved installer.

B. Protect finished surface as required and as recommended by manufacturer of polishing system.

3.06 PROTECTION

A. Protect installed coatings from subsequent construction operations.

B. Do not permit traffic over unprotected floor surface.

END OF SECTION

SECTION 03 54 00
CAST UNDERLAYMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Liquid-applied self-leveling floor underlayment.

1.02 REFERENCE STANDARDS

A. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens).

B. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.

C. ASTM C348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

A. Product Data: Provide manufacturer's data sheets documenting physical characteristics and product limitations of underlayment materials. Include information on surface preparation, mixing instructions, environmental limitations, storage and handling requirements, and installation instructions.

B. Manufacturer's Instructions: Indicate information on surface preparation, mixing instructions, environmental limitations, and installation instructions.

1.04 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing cement based products with minimum five years of documented experience.

B. Applicator Qualifications: Company specializing in performing work of type specified, with minimum 3 years of documented experience.

1.05 FIELD CONDITIONS

A. Do not install underlayment until floor penetrations and peripheral work are complete.

B. Maintain minimum ambient temperatures of 50 degrees F 24 hours before, during, and 72 hours after installation of underlayment.

C. During curing process, ventilate spaces to remove excess moisture.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cementitious Underlayment:
   1. ARDEX Engineered Cements: www.ardexamericas.com/#sle.
   2. Custom Building Products: www.custombuildingproducts.com/#sle.
   3. H.B. Fuller Construction Products, Inc[<>][<>]: www.tecspecialty.com/#sle.
   4. Mapei Corporation: www.mapei.com/#sle.
   5. Maxxon Corporation: www.maxxon.com/#sle.

2.02 MATERIALS

A. Cast Underlayments, General:
   1. Comply with applicable code for combustibility or flame spread requirements.
   2. Provide certificate of compliance from authority having jurisdiction indicating approval of underlayment materials in required fire-rated assembly.

B. Cementitious Underlayment: Blended cement mix, producing self-leveling underlayment with the following properties when mixed with water in accordance with manufacturer’s directions:

1. Compressive Strength: Minimum 4000 pounds per square inch after 28 days, tested per ASTM C109/C109M.
2. Flexural Strength: Minimum 1,000 psi after 28 days, tested in accordance with ASTM C348.
3. Density: 125 pcf, nominal.
4. Final Set Time: 1-1/2 to 2 hours, maximum.
5. Thickness: Capable of thicknesses from feather edge to maximum 3-1/2 inches.
6. Surface Burning Characteristics: Flame spread index of 0 and smoke developed index of 0 when tested in accordance with ASTM E84.

C. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to underlayment mix materials.

D. Joint and Crack Filler: Latex-based filler, as recommended by manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify substrate surfaces are clean, dry, unfrozen, and do not contain petroleum byproducts or other compounds detrimental to underlayment material bond to substrate.

3.02 PREPARATION

A. Concrete: Mechanically prepare steel troweled concrete to create surface to achieve bond; permitted methods include bead blasting and scarifying. Do not use acid etching.

B. Remove substrate surface irregularities. Fill voids and deck joints with filler. Finish smooth.

C. Vacuum clean surfaces.

D. Prime substrate in accordance with manufacturer's instructions. Allow to dry.

3.03 APPLICATION

A. Apply underlayment in accordance with manufacturer's instructions.

B. Pump or pour material onto substrate. Do not retemper or add water.
1. Pump, move, and screed while material is still highly flowable.
2. Be careful not to create cold joints.
3. Wear spiked shoes while working in wet material to avoid leaving marks.

C. For final thickness over 1-1/2 inches, place underlayment in layers. Allow initial layer to harden to point where material loses evaporative moisture. Immediately prime and begin application of subsequent layer within 24 hours.

D. Place underlayment before partition installation.

E. If fine, feathered edge is desired, steel trowel edge after initial set, but before edge completely hardens.

3.04 CURING

A. Once underlayment starts to set, prohibit foot traffic until final set is reached.

B. Air cure in accordance with manufacturer's instructions.

3.05 FIELD QUALITY CONTROL

A. Non-Conforming Work: Failure of underlayment to bond to substrate (as evidenced by a hollow sound when tapped), or disintegration or other failure of underlayment to perform as a floor finish, will be considered failure of materials and workmanship. Repair or replace underlayment in areas of such failures, as directed.

3.06 PROTECTION

A. Protect against direct sunlight, heat, and wind; prevent rapid drying to avoid shrinkage and cracking.

B. Do not permit traffic over unprotected floor underlayment surfaces.

END OF SECTION

SECTION 04 20 00
UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete block.

B. Mortar and grout.

C. Reinforcement and anchorage.

D. Flashings.

E. Accessories.

1.02 REFERENCE STANDARDS

A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

B. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

C. ASTM A951/A951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement.

D. ASTM C67/C67M - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.

E. ASTM C73 - Standard Specification for Calcium Silicate Brick (Sand-Lime Brick).

F. ASTM C90 - Standard Specification for Dry-Cast Loadbearing Concrete Masonry Units.

G. ASTM C91/C91M - Standard Specification for Masonry Cement.

H. ASTM C140/C140M - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.

I. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.

J. ASTM C150/C150M - Standard Specification for Portland Cement.

K. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.

L. ASTM C270 - Standard Specification for Mortar for Unit Masonry.

M. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.

N. ASTM C476 - Standard Specification for Grout for Masonry.

O. ASTM C744 - Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units.

P. ASTM C780 - Standard Test Methods for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.

Q. ASTM C1072 - Standard Test Methods for Measurement of Masonry Flexural Bond Strength.

R. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms.

S. ASTM C1714/C1714M - Standard Specification for Preblended Dry Mortar Mix for Unit Masonry.

T. ASTM D1056 - Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.

U. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.

V. ASTM E514/E514M - Standard Test Method for Water Penetration and Leakage Through Masonry.

W. BIA Technical Notes No. 7 - Water Penetration Resistance – Design and Detailing.

X. BIA Technical Notes No. 13 - Ceramic Glazed Brick Exterior Walls.

Y. BIA Technical Notes No. 28B - Brick Veneer/Cold-Formed Steel Framed Walls.

Z. BIA Technical Notes No. 46 - Maintenance of Brick Masonry.

AA. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all relevant installers.

1.04 SUBMITTALS

A. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.

B. Shop Drawings: Indicate pertinent dimensions, materials, anchorage, size and type of fasteners, and accessories for brickwork support system.

C. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

D. Manufacturer's Certificate: Certify that water repellent admixture manufacturer has certified masonry unit manufacturer as an approved user of water repellent admixture in the manufacture of concrete block.

E. Test Reports: Concrete masonry manufacturer's test reports for units with integral water repellent admixture.

1.05 QUALITY ASSURANCE

A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.

B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with minimum three years of documented experience.

C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.06 MOCK-UPS

A. Construct a masonry wall as a mock-up panel sized as indicated by Architect; include mortar, accessories, structural backup, and flashings (with lap joint, corner, and end dam) in mock-up.

B. Locate where directed.

C. Mock-up may remain as part of work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

A. Concrete Block: Comply with referenced standards and as follows:
   1. Size: Standard units with nominal face dimensions of 16 by 8 inches and nominal depths as indicated on drawings for specific locations.
   2. Special Shapes: Provide nonstandard blocks configured for corners.
      a. Provide bullnose units for outside corners.
   3. Load-Bearing Units: ASTM C90, normal weight.
      a. Hollow block, as indicated.
      b. Normal weight.
      c. Exposed Faces: Manufacturer's standard color and texture where indicated.
   4. Decorative and Integral Color Units: ASTM C90, normal weight.

a. Hollow block, as indicated.
b. Color: Match Architect's sample.

5. Units with Integral Water Repellent: Concrete block units as specified in this section with polymeric liquid admixture added to concrete masonry units at time of manufacture.
   a. Performance of Units with Integral Water Repellent:
      1) Water Permeance: When tested per ASTM E514/E514M and for a minimum of 72 hours.
         (a) No water visible on back of wall above flashing at the end of 24 hours.
         (b) No flow of water from flashing equal to or greater than 0.032 gallons per hour at the end of 24 hours.
         (c) No more than 25 percent of wall area above flashing visibly damp at end of test.
      2) Flexural Bond Strength: ASTM C1072; minimum 10 percent increase.
      3) Compressive Strength: ASTM C1314; maximum 5 percent decrease.
   b. Use only in combination with mortar that also has integral water repellent admixture.
   c. Use water repellent admixtures for masonry units and mortar by a single manufacturer.
   d. Location: Where indicated on Drawings.

2.02 MORTAR AND GROUT MATERIALS

A. Masonry Cement: ASTM C91/C91M, Type N.
   1. Colored Mortar: Premixed cement as required to match Architect's color sample.

B. Portland Cement: ASTM C150/C150M, Type I; color as required to produce approved color sample.
   1. Not more than 0.60 percent alkali.

C. Hydrated Lime: ASTM C207, Type S.

D. Mortar Aggregate: ASTM C144.

E. Grout Aggregate: ASTM C404.

F. Water: Clean and potable.

G. Accelerating Admixture: Nonchloride type for use in cold weather.

H. Moisture-Resistant Admixture: Water repellent compound designed to reduce capillarity.

I. Packaged Dry Material for Mortar for Unit Masonry: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C1714/C1714M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
   1. Color: Mineral pigments added as required to produce approved color sample.
   2. Water-repellent mortar for use with water repellent masonry units.

J. Packaged Dry Material for Grout for Masonry: Premixed cementitious materials and dried aggregates; capable of producing grout of the specified strength in accordance with ASTM C476 with the addition of water only.
   1. Type: Fine.

2.03 REINFORCEMENT AND ANCHORAGE

A. Manufacturers:
   1. Blok-Lok Limited: www.blok-lok.com/#sle.
   2. Hohmann & Barnard, Inc: www.h-b.com/#sle.
   3. WIRE-BOND: www.wirebond.com/#sle.

B. Reinforcing Steel: ASTM A615/A615M, Grade 40 (40,000 psi), deformed billet bars; galvanized.

C. Single Wythe Joint Reinforcement: ASTM A951/A951M.
   1. Type: Truss or ladder.

2. Material: ASTM A1064/A1064M steel wire, mill galvanized to ASTM A641/A641M Class 3.
3. Size: 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not less than 5/8 inch of mortar coverage on each exposure.

D. Flexible Anchors: 2-piece anchors that permit differential movement between masonry and building frame, sized to provide not less than 5/8 inch of mortar coverage from masonry face.
1. Steel frame: Crimped wire anchors for welding to frame, 0.25 inch thick, with trapezoidal wire ties 0.1875 inch thick, hot dip galvanized to ASTM A 153/A 153M, Class B.

E. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B.
1. Anchor plates: Not less than 0.075 inch thick, designed for fastening to structural backup through sheathing by two fasteners; provide design with legs that penetrate sheathing and insulation to provide positive anchorage.
2. Wire ties: Manufacturer's standard shape, 0.1875 inch thick.
3. Vertical adjustment: Not less than 3-1/2 inches.

F. Metal-to-Metal Fasteners: Self-drilling, self-tapping screws; corrosion resistant finish or hot dip galvanized to ASTM A153/A153M.
1. Manufacturers:
a. ITW Commercial Construction North America; Teks Select Series: www.ITWBuildex.com/#sle.

2.04 FLASHINGS

A. Rubberized asphalt Flashing: See Section 07 62 00 - Sheet Metal Flashing and Trim.

B. Combination Non-Asphaltic Flashing Materials - Stainless Steel:
1. Stainless Steel/Polymer Fabric Flashing: ASTM A240/A240M; 2 mil type 304 stainless steel sheet bonded on one side to one sheet of polymer fabric.
a. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer
b. Manufacturers:
1) Hohmann & Barnard, Inc; Mighty-Flash Stainless Flashing: www.h-b.com/#sle.
2) York Flashings; Multi-Flash SS: www.yorkflashings.com/#sle.

C. Flashing Sealant/Adhesives: Silicone, polyurethane, or silyl-terminated polyether/polyurethane or other type required or recommended by flashing manufacturer; type capable of adhering to type of flashing used.

D. Termination Bars: Stainless steel; compatible with membrane and adhesives.

E. Lap Sealants and Tapes: As recommended by flashing manufacturer; compatible with membrane and adhesives.

2.05 ACCESSORIES

A. Preformed Control Joints: Rubber material complying with ASTM D2000. Provide with corner and tee accessories, fused joints.
1. Manufacturers:
a. Blok-Lok Limited: www.blok-lok.com/#sle.
b. Hohmann & Barnard, Inc: www.h-b.com/#sle.
c. WIRE-BOND: www.wirebond.com/#sle.

B. Joint Filler: Closed cell polyvinyl chloride complying with ASTM D1056; oversized 50 percent to joint width; self expanding; in maximum lengths available.
1. Manufacturers:
a. Hohmann & Barnard, Inc: www.h-b.com/#sle.
b. WIRE-BOND: www.wirebond.com/#sle.

C. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.
   1. Mortar Diverter: Semi-rigid mesh designed for installation at flashing locations.
      a. Manufacturers:
         1) Mortar Net Solutions; MortarNet: www.mortarnet.com/#sle.
         2) WIRE-BOND: www.wirebond.com/#sle.

D. Nailing Strips: Softwood lumber, preservative treated; as specified in Section 06 10 00.

E. Weeps:
   1. Type: Molded PVC grilles, insect resistant.
   2. Manufacturers:
      a. Advanced Building Products, Inc: www.advancedbuildingproducts.com/#sle.
      b. Blok-Lok Limited: www.blok-lok.com/#sle.
      c. Hohmann & Barnard, Inc: www.h-b.com/#sle.

F. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.06 MORTAR AND GROUT MIXING

A. Mortar for Unit Masonry: ASTM C270, using the Proportion Specification.
   1. Exterior, non-loadbearing masonry: Type N.
   2. Interior, non-loadbearing masonry: Type O.

B. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio.

C. Grout: ASTM C476; consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.

D. Admixtures: Add to mixture at manufacturer's recommended rate and in accordance with manufacturer's instructions; mix uniformly.

E. Mixing: Use mechanical batch mixer and comply with referenced standards.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive masonry.

B. Verify that related items provided under other sections are properly sized and located.

C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 PREPARATION

A. Direct and coordinate placement of metal anchors supplied for installation under other sections.

B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.03 COLD AND HOT WEATHER REQUIREMENTS

A. Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

3.04 COURSING

A. Establish lines, levels, and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

C. Refer to drawings for coursing patterns.

D. Concrete Masonry Units:

1. Bond: Running.
2. Coursing: One unit and one mortar joint to equal 8 inches.
3. Mortar Joints: Concave.

3.05 PLACING AND BONDING

A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.

B. Lay hollow masonry units with face shell bedding on head and bed joints.

C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.

D. Remove excess mortar and mortar smears as work progresses.

E. Interlock intersections and external corners.

F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.

G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

H. Cut mortar joints flush where wall tile is scheduled or resilient base is scheduled.

I. Isolate masonry partitions from vertical structural framing members with a control joint as indicated.

J. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.06 WEEPS/CAVITY VENTS

A. Install weeps in veneer and cavity walls at 24 inches on center horizontally on top of through-wall flashing above shelf angles and lintels and at bottom of walls.

B. Install cavity vents in veneer and cavity walls at 32 inches on center horizontally below shelf angles and lintels and near top of walls.

3.07 CAVITY MORTAR CONTROL

A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.

B. For cavity walls, build inner wythe ahead of outer wythe to accommodate accessories.

C. Install cavity mortar diverter at base of cavity and at other flashing locations as recommended by manufacturer to prevent mortar droppings from blocking weep/cavity vents.

3.08 REINFORCEMENT AND ANCHORAGE - GENERAL

A. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches on center.

B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.

C. Place continuous joint reinforcement in first and second joint below top of walls.

D. Embed longitudinal wires of joint reinforcement in mortar joint with at least 5/8 inch mortar cover on each side.

E. Lap joint reinforcement ends minimum 6 inches.

F. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 36 inches horizontally and 24 inches vertically.

3.09 MASONRY FLASHINGS

A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.

1. Extend flashings full width at such interruptions and at least 6 inches, minimum, into adjacent masonry or turn up flashing ends at least 1 inch, minimum, to form watertight pan at nonmasonry construction.
2. Remove or cover protrusions or sharp edges that could puncture flashings.
3. Seal lapped ends and penetrations of flashing before covering with mortar.

B. Terminate flashing up 8 inches minimum on vertical surface of backing:
1. Install vertical leg of flashing behind water-resistive barrier sheet over backing.
2. Terminate vertical leg of flashing into bed joint in masonry or reglet in concrete.
3. Anchor vertical leg of flashing into backing with a termination bar and sealant.
4. Apply cap bead of sealant on top edge of self-adhered flashing.

C. Install flashing in accordance with manufacturer's instructions and BIA Technical Notes No. 7.

D. Extend metal flashings through exterior face of masonry and terminate in an angled drip with hemmed edge. Install joint sealer below drip edge to prevent moisture migration under flashing.

E. Support flexible flashings across gaps and openings.

F. Lap end joints of flashings at least 6 inches, minimum, and seal watertight with flashing sealant/adhesive.

3.10 GROUTED COMPONENTS

A. Reinforce bond beams and columns per structural documentation,

B. At bearing locations, fill masonry cores with grout for a minimum 12 inches either side of opening.

3.11 CONTROL AND EXPANSION JOINTS

A. Do not continue horizontal joint reinforcement through control or expansion joints.

B. Size control joints as indicated on drawings; if not indicated, 3/4 inch wide and deep.

C. Form expansion joint as detailed on drawings.

3.12 BUILT-IN WORK

A. As work progresses, install built-in metal door frames and glazed frames and other items to be built into the work and furnished under other sections.

B. Install built-in items plumb, level, and true to line.

C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.

D. Do not build into masonry construction organic materials that are subject to deterioration.

3.13 TOLERANCES

A. Install masonry within the site tolerances found in TMS 402/602.

B. Maximum Variation from Alignment of Columns: 1/4 inch.

C. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.

D. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.

E. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.

F. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.

G. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/4 inch, plus 3/8 inch.

H. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.14 CUTTING AND FITTING

A. Cut and fit for chases. Coordinate with other sections of work to provide correct size, shape, and location.

B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.15 FIELD QUALITY CONTROL

A. Clay Masonry Unit Tests: Test each variety of clay masonry in accordance with ASTM C67/C67M requirements, sampling 5 randomly chosen units for each 50,000 installed.

B. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140/C140M for compliance with requirements of this specification.

C. Mortar Tests: Test each type of mortar in accordance with ASTM C780, testing with same frequency as masonry samples.

3.16 CLEANING

A. Remove excess mortar and mortar droppings.

B. Replace defective mortar. Match adjacent work.

C. Clean soiled surfaces with cleaning solution.

D. Use non-metallic tools in cleaning operations.

3.17 PROTECTION

A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION

SECTION 04 73 00
MANUFACTURED STONE MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Thin adhered calcium silicate masonry units

B. Installation materials.

C. Accessories.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting work of this section.

1.03 SUBMITTALS

A. Product Data: Provide data for lightweight synthetic stone veneer, mortar, lath, water-resistive barrier, and backing panels, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

B. Shop Drawings: Submit detail drawings depicting proper installation and flashing techniques. Coordinate locations with those found on drawings.

C. Verification Samples: For each finish product specified, two samples, minimum size 12 inches square, representing actual product, color, patterns and texture.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum ten years of documented experience.

B. Installer Qualifications: Company specializing in performing work of type specified, with at least five years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Prevent mechanical damage and contamination by other materials.

1.06 FIELD CONDITIONS

A. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during, and 48 hours after completion of masonry work.

B. Maintain materials and surrounding air temperature to maximum 90 degrees F prior to, during, and 48 hours after completion of masonry work.

1.07 WARRANTY

A. Correct defective work within a five year period after Date of Substantial Completion.

B. Provide 15 year manufacturer warranty for mortar and other installation materials used in exterior installations over steel or wood framing.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Thin Brick Calcium Silicate Masonry Units
   1. Basis of design manufacturer: Arriscraft; www. arriscraft.com

2.02 THIN ADHERED CALCIUM SILICATE MASONRY UNITS

A. Thin Adhered Calcium Silicate Masonry Units (Thin Adhered CSMU) (Georgia): to ASTM C73, Grade SW; solid units that have been pressure formed and autoclaved; and then cut to [3/4”] and/or [1-3/8” (available in smooth only)] thickness; special shapes as indicated; and as follows:
   1. Modular Size: 2-1/4" high,fragmented lengths up to 23-5/8" long.
   2. Texture: weathered finish on exposed faces.
   3. Fabricate calcium silicate masonry units to the following tolerances:
      a. Unit Length: plus or minus 1/16".
      b. Unit Height: plus or minus 1/16”.
      c. Unit Bed: plus or minus 1/8”.

2.03 INSULATED CONCRETE BOARD PANELS

A. Insulated Concrete Board Panels: ¼” thick Utilicrete Concrete Board, that is water durable; surfaced with fiberglass reinforcing mesh on front and back and with long edges wrapped and then laminated to Expanded Polystyrene Insulation.
   1. Concrete Board Edges: Tapered.
   2. Compressive Strength of Concrete Board: not less than 2600 lbs. per sq. in. when tested in accordance with ASTM D 2394.
   3. Flexural Strength of Concrete Board: not less than 1500 lbs. per sq. in. when tested in accordance with ASTM C 947.
   4. Surface Burning Characteristics of Concrete Board:
      a. Flame Spread – 5 when tested in accordance with ASTM – E84
      b. Smoke Developed – 0 when tested in accordance with ASTM – E85
   5. Density of Expanded Polystyrene Rigid Insulation not less than 1.8 lbs. per c.f.
   6. Water Absorption of Expanded Polystyrene Rigid Insulation not more than 2% by volume
   7. Expanded Polystyrene Rigid Insulation to meet ASTM C 578 – 08b Type IX
   8. Basis of design product: ProGUARD®*DP* Insulated Concrete Board with the following properties:

2.04 MORTAR APPLICATIONS

A. At Contractor's option, mortar may be field-mixed from packaged dry materials, made from factory premixed dry materials with addition of water only, or ready-mixed.

B. Pointing Mortars: Pointing or grouting mortars used to fill the joints between individual units once the setting bed mortar has sufficiently cured.

2.05 ACCESSORIES

A. Flashing Tape: Recommended by manufacturer.

B. Latex Portland Cement Mortar: T-Clear Total Bond Polymer Fortified Mortar to be weather, frost, shock resistant, non-flammable and meet the ANSI 118.4 and ANSI 118.15 requirements.

C. Pointing Mortar: Portland cement-hydrated lime-sand mix

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify site conditions are ready to receive work

B. Inspect materials for fit and finish prior to installation. Do not set unacceptable units and materials.

C. Beginning of installation means acceptance of existing conditions.

3.02 CUTTING AND SIZING OF INSULATED CONCRETE BOARD PANELS

A. Cut concrete board with a masonry saw

B. If cutting foam insulation to form mitered corners cut using a hot wire saw. If cutting mineral wool insulation to form mitered corners cut using a large knife.

C. Clean cut panels. After being cut use clean water and a sponge to remove all cutting dust from the panel surfaces.

3.03 CUTTING MASONRY UNITS

A. Cut masonry units with wet-saw.

B. Pre-soak units using clean water prior to cutting.

C. Clean cut units using a stiff fibre brush and clean water. Allow units to surface dry prior to placement.

D. Finish cut edges to match face when exposed in wall.

3.04 COURSING

A. Place masonry to lines and levels indicated.

B. Maintain masonry courses to uniform width. Make vertical and horizontal joints equal and of uniform thickness.

C. Lay masonry units according to pattern indicated on drawings.

3.05 INSTALLATION - ACCESSORIES

A. Install insulated concrete board panels in accordance with manufacturer's printed installation instructions.

B. Use only materials supplied from a single source as recommended by manufacturer.

3.06 INSTALLATION – ADHERED MASONRY VENEER

A. Install in accordance with manufacturer's printed installation instructions.

B. Direct Adhere Method to Install Masonry Veneer: Install polymer fortified portland cement mortar in compliance with current revisions of ANSI A108.02 (3.11), A108.1B and ANSI A108.5. Use the appropriate trowel notch size to ensure proper bedding of the adhered masonry veneer, selected so that 100% coverage of the back surface of the Thin Adhered CSMU is achieved. Work the polymer fortified portland cement mortar into good contact with the substrate and comb with notched side of trowel. Spread only as much polymer fortified portland cement mortar as can be covered while the mortar surface is still wet and tacky. When installing large format (>8” x 8”/200mm x 200mm) units, spread latex portland cement mortar onto the back of (i.e. ‘back-butter’) each piece/unit in addition to troweling latex portland cement mortar over the substrate. Beat each piece/unit into the latex portland cement mortar with a beating block or rubber mallet to insure 100% full bedding and flatness. Allow installation to set until firm. Clean excess latex portland cement mortar from adhered masonry veneer face and joints between pieces.

3.07 CLEANING

A. Remove excess mortar and mortar smears as work progresses.

B. Clean soiled surfaces with cleaning solution.

3.08 PROTECTION

A. Protect finished work from rain during and for 48 hours following installation.

B. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Structural steel.
   2. Prefabricated building columns.

B. Related Sections:

   1. Section 01 45 23 "Testing and Inspection Services".
   2. Section 05 31 13 "Steel Floor Decking".
   3. Section 05 31 23 "Steel Roof Decking".
   4. Section 05 50 00 "Metal Fabrications".
   5. Section 05 51 00 "Metal Stairs."

1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:
   1. Shapes included in ASTM A 6 with flanges thicker than 1 1/2 inches.
   2. Welded built-up members with plates thicker than 2 inches.
   3. Column base plates thicker than 2 inches.

D. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

1.4 REFERENCES

A. Comply with applicable provisions of the following specifications and documents: The latest adopted edition of all standards referenced in this section shall apply, unless noted otherwise
   1. AISC "Code of Standard Practice for Steel Buildings and Bridges”.
   2. AISC "Specification for Structural Steel Buildings," including the "Commentary" and the Supplements thereto, as issued.
   3. AISC "Specification for Architecturally Exposed Structural Steel”.
   4. AISC's "Seismic Provisions for Structural Steel Buildings”.
   5. ASTM A 6 "Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use”.
   6. AWS D1.1 Structural Welding Code.
   7. Research Council on Structural Connections' (RCSC) "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".
   8. Research Council on Structural Connections' (RCSC) "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts”.
   9. SSPC (Steel Structures Painting Council), Painting Manuals, Volumes 1 and 2.
   10. UL Fire Resistance Directory.

B. In the case of conflict between the Contract Documents and a reference standard, the Contract Documents shall govern. In the case of a conflict between the Contract Documents and the Building Code, the more stringent shall govern.

1.5 PERFORMANCE REQUIREMENTS

A. Delegated Design: Prepare submittal documents including connection design calculations and drawings signed and sealed by registered design professional, licensed in state where project is located, employed by the steel fabricator.

B. Design all structural steel framing connections complying with specified performance:
   1. Load Capacity: Resist loads indicated on drawings or resist full capacity of supported framing member if reaction not indicated. Account for connection and member loads and eccentricities.
      a. Request additional design criteria when necessary to complete connection design.
   2. Configuration: Design and detail all connections for each member size, steel grade and connection type to resist the loads and reactions indicated on the drawings or specified herein. Use details consistent with details shown on drawings, supplementing where necessary. The details shown on drawings are conceptual and do not indicate the required weld sizes or number of bolts unless specifically noted. Use rational engineering design and standard practice in detailing, accounting for all loads and eccentricities in both the connection and the members. Promptly notify the design professional in charge of any location where the connection design criteria is not clearly indicated. The design of all connections is subject to the review and acceptance of the design professional in charge. Submit structural calculations prepared and sealed by a qualified engineer registered in the state where the project is located. Submit calculations for review before preparation of detail drawings.

C. Construction: System as indicated on Drawings.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
5. Identify members and connections of the seismic-load-resisting system.
6. Indicate locations and dimensions of protected zones.
7. Identify demand critical welds.
8. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. At full penetration welds, Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand critical welds.

1.7 INFORMATIONAL SUBMITTALS

A. Submit the following informational submittals:
1. Qualification Data: For qualified installer, fabricator, and testing agency.
2. Welding certificates.
3. Mill test reports for structural steel, including chemical and physical properties.
4. Product Test Reports: For the following:
   a. Bolts, nuts, and washers including mechanical properties and chemical analysis.
   b. Direct-tension indicators.
   c. Tension-control, high-strength bolt-nut-washer assemblies.
   d. Shear stud connectors.
   e. Shop primers.
5. Source quality-control reports.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator with a minimum of (5) years of experience that participates in the AISC Quality Certification Program for Category I or higher structures and is designated and is designated an AISC-Certified Plant, Category STD. An otherwise qualified fabricator who is not a member of the AISC Quality Certification Program will be accepted if satisfactory evidence of qualifications is submitted prior to award of Contract. For non-certified

fabricators, Contractor shall submit a resume describing plant size, equipment quality control procedures and personnel, and experience on comparable work in the last five (5) years.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1, P2, or P3 as applicable for exposure or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

E. Comply with applicable provisions of the following specifications and documents:
1. AISC 303.
2. AISC 341 and AISC 341s1.
3. AISC 360.
4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

F. Preinstallation Conference: Conduct conference at Project site.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.10 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:

1. W-Shapes: 60 percent.
2. Channels, Angles, M, S-Shapes: 60 percent.
3. Plate and Bar: 25 percent.
4. Cold-Formed Hollow Structural Sections: 25 percent.
5. Steel Pipe: 25 percent.
6. All Other Steel Materials: 25 percent.

B. W-Shapes: Refer Structural General Notes.

C. Channels, Angles, M, S-Shapes: Refer Structural General Notes.

D. Plate and Bar: Refer Structural General Notes.

E. Corrosion-Resisting Structural-Steel Shapes, Plates, and Bars: ASTM A 588, Grade 50.

F. Cold-Formed Hollow Structural Sections: Refer Structural General Notes.

G. Steel Pipe: Refer Structural General Notes.

1. Weight Class: See Plans.
2. Finish: Black except where indicated to be galvanized.

H. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts.

1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

B. Zinc-Coated High-Strength Bolts, Nuts, and Washers (All bolts located in Crawl Space): ASTM A 325, Type 1, heavy-hex steel structural bolts.

1. Finish: Hot-dip or mechanically deposited zinc coating.
2. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with mechanically deposited zinc coating finish.

C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex or round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Plain or Mechanically deposited zinc coating, where required.

D. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.

E. Unheaded Anchor Rods: ASTM F 1554, See Anchor Bolt Schedule on Drawings for Grade.

1. Configuration: Straight.
2. Nuts: ASTM A 563 heavy-hex carbon steel.
3. Plate Washers: ASTM A 36 carbon steel.
4. Washers: ASTM F 436, Type 1, hardened carbon steel.
5. Finish:
   a. General Condition – Plain
   b. Crawl Space - Hot-dip zinc coating, ASTM A 153, Class C.

F. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.

G. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.

H. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

I. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Amscot Structural Products Corp.
   b. Fluorocarbon Company Limited.
   c. R.J. Watson Bridge & Structural Engineered Systems.
   d. Seismic Energy Products, L.P.
2. Mating Surfaces: PTFE and PTFE or mirror-finished stainless steel.
3. Coefficient of Friction: Not more than 0.05.
4. Design Load: Not less than 5,000 psi .

5. Total Movement Capability: 2 inches.

2.3 PRIMER

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Primer (General): Fabricator's standard lead- and chromate-free, non-asphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

C. Primer (Crawl Space Steel): Tnemec Perimeprime Series 394.

D. Galvanizing Repair Paint: SSPC-Paint 20.

2.4 GROUT

A. Refer Section 03 30 00.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
   1. Camber structural-steel members where indicated.
   2. Fabricate beams with rolling camber up.
   3. Identify high-strength structural steel according to ASTM A 6 and maintain markings until structural steel has been erected.
   4. Mark and match-mark materials for field assembly.
   5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate structural steel according to AISC specifications referenced in this Section and in final approved Shop Drawings.
   1. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize field handling of materials.
   2. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other effects.
   3. Camber structural steel members where indicated. The camber specified is the camber that is measured in the field with the beam on its side so that the beam weight has no effect. During shipment and handling, cambered members shall be supported in a way that will not result in loss of camber.
   4. Camber tolerance
      a. Beams 50 feet and less; plus or minus 1/2 inch.

b. Beams greater than 50 feet; plus or minus 1/2 inch, except tolerance can be increased 1/8 inch for each 10 feet or fraction thereof in excess of 50 feet.
c. Contact engineer for members outside specified camber tolerance. Provide engineer with a list of beam locations and actual measured camber amounts. Submit an engineered shoring plan, if requested, that will allow the beam to deflect to the horizontal position after concrete placement without overloading the framing below.

5. Complete structural steel assemblies, including welding of units, before starting shop-priming operations.
6. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.

C. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

D. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

E. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

F. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, "Power Tool Cleaning."

G. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

H. Holes for Other Work: Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on approved shop drawings.
1. Provide threaded nuts welded to framing, and other specialty items as indicated to receive other work.
2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes by burning.

I. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces. Base plates hole sizes for anchor bolts may be oversized to facilitate erection:
1. Bolts 3/4inch to 7/8 inch diameter: 1/2 inch oversize.
2. Bolts 1 inch to 1 1/2 inch diameter: 3/4 inch oversize.
3. Bolts over 1 3/4 inch diameter: 1 inch oversize.

J. Base Plate Washers: Sizes shall be as follows:
1. 3/4 inch diameter Bolts: 2 inch diameter x 1/4 inch thick
2. 7/8 inch diameter Bolts: 2 1/2 inch diameter x 5/16 inch thick
3. 1 inch diameter Bolts: 3 inch diameter x 3/8 inch thick
4. 1 1/4 inch diameter Bolts: 3 inch diameter x 1/2 inch thick
5. 1 1/2 inch diameter Bolts: 3 1/2 inch diameter x 1/2 inch thick
6. 1 3/4 inch diameter Bolts: 4 inch diameter x 5/8 inch thick
7. 2 inch diameter Bolts: 5 inch diameter x 3/4 inch thick

K. Architecturally Exposed Structural Steel (AESS): Fabricate with exposed surfaces smooth, square, and free of surface blemishes, including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness.
   1. Remove blemishes by filling, grinding, or by welding and grinding, prior to cleaning, treating, and shop priming.
   2. Comply with fabrication requirements, including tolerance limits, of AISC's "Specification for Architecturally Exposed Structural Steel" for architecturally exposed structural steel.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

   1. Joint Type: Snug tightened, Pretensioned, or Slip critical as required or indicated on Drawings.

B. Weld Connections: Comply with AWS D1.1 and AWS D1.8, where required, for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

   1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

   1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
   2. Surfaces to be field welded.
   3. Surfaces to be high-strength bolted with slip-critical connections.
   4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing) excluding crawl space steel. Crawl space steel shall be primed regardless of whether it is to receive fireproofing.
   5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

   1. SSPC-SP 2, "Hand Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

D. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

E. Crawl space steel to be primed to a DFT between 2.5 and 3.5 mils.

F. Painting: Prepare steel and apply a one-coat, non-asphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.

2.8 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123.

1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.

2. Galvanize lintels and shelf angles attached to structural steel frame and located in exterior walls.

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Refer Section 01 45 23.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete and masonry bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations, to elevations indicated, and according to AISC 303 and AISC 360.

B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow it to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened, Pretensioned, or Slip critical as indicated on Drawings.

B. Weld Connections: Comply with AWS D1.1 and AWS D1.8 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.

3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: See Section 01 45 23.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

END OF SECTION 05 12 00

SECTION 05 21 00
STEEL OPEN WEB JOIST FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. K-series steel joists.
   2. KCS-type K-series steel joists.
   3. K-series steel joist substitutes.
   4. Joist accessories.
      a. Extended ends.
      b. Ceiling extensions.
      c. Bearing plates.
      d. Bridging.
      e. Side wall anchors.

B. Related Requirements:
   1. Section 03 30 00 "Cast-in-Place Concrete".
   2. Section 01 45 23 “Testing and Inspection Services”
   3. Section 04 20 00 "Unit Masonry".
   4. Section 05 12 00 "Structural Steel Framing".
   5. Section 05 31 13 “Steel Floor Decking”.
   6. Section 05 31 23 “Steel Roof Decking”.

1.3 REFERENCES

A. Comply with applicable provisions of the following specifications and documents. The latest adopted edition of all standards referenced in this section shall apply, unless noted otherwise.
   1. AWS D1.1 Structural Welding Code
   2. SJI “Standard Specification Load Tables and Weight Tables for Steel Joists and Joist Girders”.
   3. SDI “Design Manual for Composite Decks, Form Decks, Roof Decks, Cellular Metal Floor Deck with Electrical Distribution”.
   4. SSPC Steel Structures Painting Council Painting Manual.
   5. UL Fire Resistance Directory.
   6. ICBO Product Evaluation Reports.
   7. FM Roof Assembly Classifications.

B. In the case of conflict between the Contract Documents and a reference standard, the Contract Documents shall govern. In the case of a conflict between the Contract Documents and the Building Code, the more stringent shall govern.

1.4 DEFINITIONS

A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support non-uniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of joist, accessory, and product.

B. LEED Submittals:
1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Laboratory Test Reports for Credit EQ 4: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings:
1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details, bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
3. Indicate locations and details of bearing plates to be embedded in other construction.
4. Shop drawings containing special joists shall be submitted with a design load summary for each special joist design. Load summary will be reviewed and returned with the joist submittal. Shop drawings containing special joists submitted without the specified load summary will be returned unchecked as an incomplete submittal. Shop drawings containing special joists shall be signed and sealed by the qualified professional engineer responsible for the design of the joists.

1.6 INFORMATIONAL SUBMITTALS

A. Submit the following informational submittals:
1. Qualification Data: For manufacturer.
2. Welding certificates.
3. Manufacturer certificates.
4. Mill Certificates: For each type of bolt.
5. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."
   1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications."

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.9 SEQUENCING

A. Deliver steel bearing plates to be built into cast-in-place concrete and or masonry construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.
   1. Use ASD; data are given at service-load level.
   2. Design special joists to withstand design loads with live-load deflections no greater than the following:
      a. Floor Joists: Vertical deflection of 1/360 of the span.
      b. Roof Joists: Vertical deflection of 1/360 of the span.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

2.2 MATERIALS

A. Steel: Comply with SJI’s “Specifications” for chord and web members.

2.3 K-SERIES STEEL JOISTS

A. Manufacture steel joists of type indicated according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.

1. Joist Type: K-series steel joists and KCS-type K-series steel joists.

B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.

C. Provide holes in chord members for connecting and securing other construction to joists.

D. Top-Chord Extensions and Extended Ends: Provide top chord extension or extended ends where shown on plans. Design for load indicated on plans.

E. Camber joists according to SJI's Specifications unless noted otherwise.

F. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.4 PRIMERS

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

2.5 JOIST ACCESSORIES

A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" and "Standard Specifications for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.

B. Fabricate steel bearing plates from ASTM A 36/A 36M steel with integral anchorages of sizes and thicknesses indicated. Shop prime paint for interior exposure or Hot-dip zinc coat according to ASTM A 123/A 123M for exterior or weather exposure.

C. Furnish ceiling extensions (where indicated), either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch of finished wall surface unless otherwise indicated.

D. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A, carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.
1. Finish: Plain, uncoated.

E. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
1. Finish: Plain.

F. Welding Electrodes: Comply with AWS standards.

G. Galvanizing Repair Paint: ASTM A 780.

H. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.6 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.

B. Do not prime paint joists and accessories to receive sprayed fire-resistive materials.

C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1.5 mil thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications", "Standard Specifications for Composite Steel Joists, CJ-Series" in "Standard Specifications for Composite Steel Joists, Weight Tables and Bridging Tables, Code of Standard Practice," joist manufacturer's written recommendations, and requirements in this Section.
   1. Before installation, splice joists delivered to Project site in more than one piece.
   2. Space, adjust, and align joists accurately in location before permanently fastening.
   3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
   4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.

C. Field weld joists to supporting steel bearing plates and framework as indicated on Drawings. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance, and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using high-strength structural bolts as indicated on Drawings. Comply with Research Council on Structural Connection's "Specification for

Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.

E. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: See Section 01 45 23.

3.4 REPAIR AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.
   1. Clean and prepare surfaces by hand-tool cleaning according to SSPC-SP 2, or power-tool cleaning according to SSPC-SP 3.
   2. Apply a compatible primer of same type as primer used on adjacent surfaces.

C. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that joists and accessories are without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 21 00

SECTION 05 31 23
STEEL ROOF DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Roof deck.
2. Noncomposite vented roof deck.

B. Related Requirements:
1. Section 01 45 23 “Structural Testing and Inspection Services”
2. Section 05 12 00 "Structural Steel Framing".
3. Section 05 50 00 "Metal Fabrications".

1.3 REFERENCES

A. Comply with applicable provisions of the following specifications and documents. The latest adopted edition of all standard referenced in this section shall apply, unless noted otherwise.
1. AWS D1.1 – Structural Welding Code
2. AWS D1.3 – Structural Welding Code – Sheet Steel
3. SDI – Design Manual
4. SSPC – Painting Manual
5. UL – Fire Resistance Directory
6. ICBO – Product Evaluation Reports
7. FM – Roof Assembly Classifications

B. In the case of conflict between the Contract Documents and a referenced standard, the Contract Documents shall govern. In the case of a conflict between the Contract Documents and the Building Code, the more stringent shall govern.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

2. Laboratory Test Reports for Credit EQ 4: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings:
1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Power-actuated mechanical fasteners.
2. Acoustical roof deck.

D. Evaluation Reports: For steel deck.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Refer Section 01 45 23.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

C. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

D. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 ROOF DECK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. ASC Profiles, Inc.; a Blue Scope Steel company.
   2. Canam United States; Canam Group Inc.
   3. CMC Joist & Deck.
   4. Consolidated Systems, Inc.; Metal Dek Group.
   5. Cordeck.
   6. DACS, Inc.
   7. Epic Metals Corporation.
   8. Marlyn Steel Decks, Inc.
   9. New Millennium Building Systems, LLC.
   10. Nucor Corp.; Vulcraft Group.
   11. Roof Deck, Inc.
   12. Valley Joist; Subsidiary of EBSCO Industries, Inc.
   13. Verco Manufacturing Co.
   14. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

   1. Prime-Painted Steel Sheet: ASTM A 1008, Structural Steel (SS), Grade 40 minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
      a. Color: Manufacturer's standard.

   2. Galvanized-Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 40, G90 zinc coating.

3. Galvanized and Shop-Primed Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 40, G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

   a. Color: Manufacturer's standard.

4. Deck Profile: As indicated on plan.

5. Profile Depth: As indicated on plan.

6. Design Uncoated-Steel Thickness: As indicated in Structural General Notes.

7. Span Condition: Triple span or more.

8. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.3 NONCOMPOSITE VENTED ROOF DECK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ASC Profiles, Inc.; a Blue Scope Steel company.
2. Canam United States; Canam Group Inc.
3. CMC Joist & Deck.
4. Consolidated Systems, Inc.; Metal Dek Group.
5. Marlyn Steel Decks, Inc.
6. New Millennium Building Systems, LLC.
7. Nucor Corp.; Vulcraft Group.
8. Roof Deck, Inc.
9. Verco Manufacturing Co.
10. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

B. Noncomposite Vented Roof Deck: Fabricate ribbed- and vented-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 31, and with the following:

1. Galvanized-Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 40, G90 zinc coating.

2. Profile Depth: As indicated in Structural General Notes.

3. Design Uncoated-Steel Thickness: As indicated in Structural General Notes.
4. Span Condition: Triple span or more.
5. Side Laps: Overlapped or interlocking seam at Contractor's option.

6. Vent Slot Area: Manufacturer's standard vent slots providing 1-1/2.

2.4 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth unless otherwise indicated.

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

H. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch thick, with factory-punched hole of 3/8-inch minimum diameter.

I. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

J. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch- wide flanges and sloped recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.

K. Galvanizing Repair Paint: ASTM A 780.

L. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

1. Fasteners shall provide diaphragm shear and uplift resistance equal to or greater than welding indicated herein and on Drawings.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:

1. Weld Diameter: As indicated on Structural Plans.
2. Weld Spacing: As indicated on Structural Plans.
3. Weld Washers: Install weld washers at each weld location if deck gauge is lighter than 22 gauge.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals shown on Structural Plans:

1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
2. Fasten with a minimum of 1-1/2-inch- long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped 2 inches minimum or butted at Contractor's option.

D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld or mechanically fasten flanges to top of deck. Space welds or mechanical fasteners not more than 12 inches apart with at least one weld or fastener at each corner.
   1. Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasten.

E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
   1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: See Section 01 45 23.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.5 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

   1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 31 23

SECTION 05 40 00

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Requirements including but not limited to:
   1. Load bearing wall framing.
   2. Exterior nonload bearing wall framing.
   3. Floor joist framing.
   4. Roof rafter framing.
   5. Ceiling joist framing.
   6. Soffit framing.
   7. Accessories necessary for a complete installation.

1.3 RELATED SECTIONS

A. Section 05 5000 – Metal Fabrications.

B. Section 09 2116 – Gypsum Board.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, licensed in the State of Texas, to design cold formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
   1. Design Loads: Indicated on Structural Drawings.
   2. Coordinate the requirements on the Structural Drawings with the requirements of this Section. If a conflict exists, notations on the Structural Drawings take precedence.
   3. The following document governs the Work, except where more restrictive items are specified:
      AISI Design of Cold-Formed Steel Structural Members Wind Load
      Minimum Design Loads
      1. As required by code officials having jurisdiction.
      2. Deflection: 1/600 for clear simple spans
      3. Deflection: 1/300 for cantilever conditions and roof parapets
      4. Gauge: 18 gauge minimum, unless noted otherwise.

   4. Welding Qualifications: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".
   5. Studs, tracks, channels, and other light gauge framing members shall conform to requirements of ASTM C955.

6. Fire-Rated Assemblies: Where framing units are components of assemblies indicated for a fire-resistance rating, including those required for compliance with governing regulations, provide units that have been approved by governing authorities that have jurisdiction.
7. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 degrees F (67 degrees C).
8. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure:
   a. Upward and downward movement of 1-1/2 inches (38 mm).

9. Design exterior nonload bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold Formed Steel Framing Design Standards:
1. Floor and Roof Systems: AISI S210.
2. Wall Studs: AISI S211.
3. Headers: AISI S212.
4. Lateral Design: AISI S213.

1.5 SUBMITTALS

A. Product Data: Technical data for cold formed steel framing product and accessories including factory applied primers.

B. Shop Drawings: Submit layout, spacings, sizes, thickness, and types of cold formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
1. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Supplementary Design Details: The general design is presumed adequate to permit compliance with the specified performance. Provide engineering calculations to supplement the general design. Calculations shall bear the seal of a Registered Professional Engineer, licensed in the State of Texas. Calculations must show design will with stand wind loading commiserate with class and rating of the project.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M Structural Welding Code - Steel.
   b. AWS D1.3/D1.3M Structural Welding Code - Sheet Steel.

2. Comply with AISI North American Specification for the Design of Cold Formed Steel Structural Members and Standard for Cold Formed Steel Framing - General Provisions.
   a. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.
   b. Comply with AISI S230 Standard for Cold Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings.

3. Fire Resistance Ratings: ASTM E 119; testing by a UL. Identify products with appropriate markings of applicable testing agency. Indicate design designations from UL *Fire Resistance Directory*.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Texas and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold formed metal framing that are similar to those indicated in material, design, and extent.
1. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and structural data.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect cold formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CEMCO; California Expanded Metal Products Co.
2. ClarkDietrich Building Systems.
3. Consolidated Fabricators Corp.; Building Products Division.
4. Marino\WARE.
5. SCAFCO Corporation.
6. The Steel Network.

2.2 LOAD BEARING WALL FRAMING

A. Steel Studs: C shaped steel studs, of web depths indicated, punched, with stiffened flanges:
1. Minimum Base Metal Thickness: 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
2. Flange Width: 1-5/8 inches (41 mm).
3. Section Properties: Refer to the Drawings.

B. Steel Track: U shaped steel track, of web depths indicated, unpunched, with straight flanges:
1. Minimum Base Metal Thickness: 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
2. Flange Width: 1-1/4 inches (32 mm).

C. Steel Box or Back to Back Headers: C shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges:
1. Minimum Base Metal Thickness: 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
2. Flange Width: 1-5/8 inches (41 mm).

D. Steel Single or Double L Headers: L shapes used to form header beams, of web depths indicated:

1. Minimum Base Metal Thickness: 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
2. Top Flange Width: 1-5/8 inches (41 mm).
3. Section Properties: Refer to the Drawings.

2.3 EXTERIOR NONLOAD BEARING WALL FRAMING

A. Steel Studs: C shaped steel studs, of web depths indicated, punched, with stiffened flanges:
   1. Minimum Base Metal Thickness: 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
   2. Flange Width: 1-5/8 inches (41 mm).
   3. Section Properties: Refer to the Drawings.

B. Steel Track: U shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
   1. Minimum Base Metal Thickness: 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
   2. Flange Width: 1-1/4 inches (32 mm).

C. Vertical Deflection Clips: Head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AllSteel & Gypsum Products, Inc.
      b. ClarkDietrich Building Systems.
      c. Marino\WARE.
      d. SCAFCO Corporation.
      e. Simpson Strong-Tie Co., Inc.
      f. Steel Network, Inc. (The).
      g. Steeler, Inc.

D. Single Deflection Track: Single, deep leg, U shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure:
   1. Minimum Base Metal Thickness: 0.0428 inch (1.09 mm), 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
   2. Flange Width: 1 inch (25 mm) plus the design gap for one story structures and 1 inch (25 mm) plus twice the design gap for other applications.

E. Double Deflection Tracks: Double, deep leg, U shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.
   1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure:
      a. Minimum Base Metal Thickness: 0.0428 inch (1.09 mm), 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
      b. Flange Width: 1 inch (25 mm) plus the design gap for one story structures and 1 inch (25 mm) plus twice the design gap for other applications.

   2. Inner Track: Of web depth indicated:
      a. Minimum Base Metal Thickness: 0.0428 inch (1.09 mm), 0.0538 inch (1.37 mm), 0.0677 inch (1.72 mm), and 0.0966 inch (2.45 mm).
      b. Flange Width: 1 inch (25 mm) plus the design gap for one story structures and 1 inch (25 mm) plus twice the design gap for other applications.

F. Drift Clips: Bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.4 SOFFIT FRAMING

A. Exterior Soffit Frame: C shaped steel sections, of web depths indicated, with stiffened flanges:
   1. Minimum Base Metal Thickness: 0.0428 inch (1.09 mm)] [0.0538 inch (1.37 mm).
   2. Flange Width: 1-5/8 inches (41 mm) minimum.

2.5 FRAMING ACCESSORIES

A. Fabricate steel framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of appropriate thickness and configuration, unless otherwise indicated:
   1. Supplementary framing.
   2. Bracing, bridging, and solid blocking.
   3. Web stiffeners.
   4. Anchor clips.
   5. End clips.
   6. Foundation clips.
   7. Gusset plates.
   8. Stud kickers and knee braces.
   9. Joist hangers and end closures.
   10. Hole reinforcing plates.
   11. Backer plates.

C. Anchors, Clips, and Fasteners:
   1. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot dip process according to ASTM A 123/A 123M.
   2. Expansion Anchors: Fabricated from corrosion resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.
   3. Power Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
   4. Mechanical Fasteners: ASTM C 1513, corrosion resistant coated, self-drilling, self-tapping, steel drill screws.
      a. Head Type: Low profile head beneath sheathing.

   5. Welding Electrodes: Comply with AWS standards.

D. Miscellaneous Materials:
   1. Galvanizing Repair Paint: SSPC-Paint 20 or ASTM A 780.
   2. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage compensating agents, and plasticizing and water reducing agents, complying with ASTM C 1107/C 1107M, with fluid consistency and 30 minute working time.
   3. Shims: Load bearing, high density multimonomer plastic, and nonleaching; or of cold formed steel of same grade and coating as framing members supported by shims.

4. Sealer Gaskets: Closed cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from standard widths to match width of bottom track or rim track members.

2.6 FABRICATION

A. Fabricate cold formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI specifications and standards, manufacturer written instructions, and specified requirements.
   1. Fabricate framing assemblies using jigs or templates.
   2. Cut framing members by sawing or shearing; do not torch cut.
   3. Fasten cold formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
   1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   2. Squareness: Fabricate each cold formed steel framing assembly to a maximum out of square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the work.

3.2 PREPARATION

A. Before sprayed fire resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire resistive materials, remove only as much as necessary to complete installation of cold formed framing without reducing thickness of fire resistive materials below required thickness to obtain fire resistance rating indicated. Protect remaining fire resistive materials from damage.

C. Install load bearing shims or grout between the underside of load bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch (6 mm) to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 ERECTION

A. General:
   1. Track Anchors: Install anchors maximum 4 feet - 0 inches on center; design anchors and spacing to carry live, dead and wind loads.
   2. Track Splices: Provide channel inserts or weld track splices.
   3. Erection: Install members plumb, level, and in a true plane.
   4. Fastenings: Make assembly rigid and secure, with welds free of voids and burnouts.

B. Install metal framing systems in accordance with stud manufacturer's printed instructions.

C. Runner Tracks:
   1. Install continuous tracks sized to match studs.
   2. Align tracks accurately to layout at base and tops of studs.
   3. Secure tracks as recommended by stud manufacturer, except do not exceed 24 inches on center for nail or power-driven fasteners, nor 16 inches on center for other types of attachment.
   4. Provide fasteners at corners and ends of tracks.
   5. Tracks shall be anchored to structural steel prior to installing sprayed on insulation.
   6. Provide Deflection Track (DT), at top of stud walls at floor or roof above, typically. Allow for 1/2 inch movement of primary structure. Do not attach studs directly to Deflection Track.
   7. Vertical Deflection Clips: Provide manufacturer’s standard bypass and head clips, capable of accommodating upward and downward vertical displacement of primary structure

D. Secure studs to top track and bottom runner track by means of approved self-drilling screws or welding at both inside and outside flanges of 14 gauge or heavier material. Screws and welds shall be of sufficient size to insure strength of connection. All welding shall comply with American Welding Society "Specification for Welding Sheet Steel in Structures."

E. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.

F. Where stud system abuts structural columns or walls, including masonry walls, anchor ends of stiffeners to supporting structure. Use Zee clips as specified above. Weld "Z" shaped clips to structural members as shown on drawings. Maximum 2 feet on center vertical.

G. Install supplementary framing, blocking and bracing in the metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, and similar work requiring attachment to the wall or partition. Where type of supplementary support is not otherwise indicated, comply with the stud manufacturer's recommendations and industry standards in each case, considering the weight or loading resulting from the item supported.

H. Frame wall openings with extra studs, equal to the number of studs interrupted by wall openings, placed at each side of wall openings. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with shoes or by welding, and space jack studs same as full-height studs of the wall. Secure stud system all around to wall opening frame in the manner indicated.

I. Install bracing/bridging in accordance with manufacturer’s instructions and design conditions.

J. Touch up field welds and damaged galvanized coating, except touch up of field cut studs is not required.

K. Frame both sides of expansion and control joints with separate studs; do not bridge the joint with components of stud system.

L. Install horizontal stiffeners in stud system, space (vertical distance) at no more than 54 inches on center. Weld at each intersection.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Requirements including but not limited to:
1. Steel framing and supports for operable partitions.
2. Steel framing and supports for overhead doors and grilles.
3. Steel framing and supports for countertops.
4. Steel tube reinforcement for low partitions.
5. Steel framing and supports for mechanical and electrical equipment.
6. Support angles for elevator door sills.
7. Elevator machine beams, hoist beams, and divider beams.
8. Steel shapes for supporting elevator door sills.
9. Shelf angles.
10. Metal ladders.
11. Ladder safety cages.
12. Elevator pit sump covers.
13. Miscellaneous steel trim including steel angle corner guards, steel edgings, and loading dock edge angles.
14. Metal bollards.
15. Abrasive metal nosings, treads, and thresholds.
16. Loose bearing and leveling plates.
17. Loose steel lintels.
18. Steel weld plates and angles for casting into concrete for applications.
19. Accessories necessary for a coordinated and complete installation.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design ladders and countertop supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Ladders: Provide ladders and landings capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

C. Structural Performance:
1. Countertops and Vanities: Provide countertop and vanity framing capable of withstanding the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections, or of exhibiting excessive deflections in any of the components making up the countertops and vanities:
a. All deadloads.
b. 500 pound live load placed on the countertop and vanity.

c. Deflection at Midspan: L/1000 times span or 1/8 inch whichever is less.

D. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C), material surfaces.

1.4 SUBMITTALS

A. Product Data: Submit data for miscellaneous metal fabrications and paint, coatings, and grout accessories.

B. Shop Drawings: Submit shop drawings detailing the fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
1. For installed products indicated to comply with design loads, include structural analysis data, for information only, signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Welding certificates.

E. Paint Compatibility Certificates: Submit manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Building Code: Comply with applicable requirements of the IBC for metal fabrications.
2. Welding: Qualify procedures and personnel according to the following:
a. AWS D1.1/D1.1M Structural Welding Code - Steel.
b. AWS D1.2/D1.2 M Structural Welding Code - Aluminum.
c. AWS D1.6/D1.6M Structural Welding Code - Sheet Steel.
d. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Fabricator/Installer Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project for a minimum of 5 years, with a record of successful in service performance, with sufficient production capacity to produce required units without causing delay in the work.

C. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of metal fabrications that are similar to those indicated in material, design, and extent.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.
   1. Established Dimensions: Where field measurements cannot be made without delaying the work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
   2. Provide allowance for trimming and fitting at site.

1.7 STORAGE, DELIVERY AND HANDLING

A. Store metal fabrications in a dry, well ventilated, weathertight place. Deliver and handle so as to prevent any type of damage to the fabricated work.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Rolled Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

D. Rolled Stainless Steel Floor Plate: ASTM A 793.

E. Abrasive Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallically bonded to steel.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. IKG Industries, a division of Harsco Corporation.
      b. SlipNOT Metal Safety Flooring; W.S. Molnar Company.

F. Steel Tubing: ASTM A 500/A 500M, cold formed steel tubing.

G. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

H. Slotted Channel Framing: Cold formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: 1-5/8 inches by 1-5/8 inches (41 mm by 41 mm).
2. Material: Galvanized steel, ASTM A 653/A 653M, commercial steel, Type B. with G90 (Z275) coating; [0.108 inch (2.8 mm) nominal thickness.
3. Cold Formed Metal Channels: Flange edges returned toward web and with 9/16 inch (14.3 mm) wide slotted holes in webs at 2 inches (51 mm) o.c.
4. Width of Channels: 1-5/8 inches (41 mm).
5. Depth of Channels: Indicated on Drawings.
6. Metal and Thickness: Galvanized steel complying with ASTM A 653/A 653M, structural quality, Grade 33 (Grade 230), with G90 (Z275) coating; 0.108 inch (2.8mm) nominal thickness.
7. Finish: Hot dip galvanized after fabrication.

I. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

J. Fasteners: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
   1. Provide stainless steel fasteners for fastening aluminum.
   2. Provide stainless steel fasteners for fastening stainless steel.
   3. Provide stainless steel fasteners for fastening nickel silver.
   4. Provide bronze fasteners for fastening bronze.
   5. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
   6. Steel Bolts and Nuts: Regular hexagon head bolts, ASTM A 325, Type 3 (ASTM A 325M, Type 3); with hex nuts, ASTM A 563, Grade C3 (ASTM A 563M, Class 8S3); and, where indicated, flat washers.
   7. Stainless Steel Bolts and Nuts: Regular hexagon head annealed stainless steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers; Alloy.
   8. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
      a. Hot dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
   9. Anchors: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
   10. Cast in Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot dip galvanized per ASTM F 2329.
   11. Post Installed Anchors: Torque controlled expansion anchors.
      a. Material for Interior Locations: Carbon steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
      b. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 (A4) stainless steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

12. Slotted Channel Inserts: Cold formed, hot dip galvanized steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee head bolts, complete with washers and nuts, all zinc plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

K. Miscellaneous Materials:
1. Shop Primer for Ferrous Metal: Universal primer, organic zinc rich primer, complying with SSPC-Paint 20 and compatible with topcoat. Provide 10-99 (red) or 10-09 (gray) by Tnemec Company.
2. Universal Shop Primer: Fast curing, lead and chromate free, universal modified alkyd primer and compatible with topcoat. Use primer containing pigments that make it easily distinguishable from zinc rich primer.
3. Water Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel and compatible with topcoat.
4. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc coated metal and compatible with finish paint systems indicated.
5. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in steel, complying with SSPC-Paint 20. Provide Tneme-Zinc 90-97 by Tnemec Company.
6. Bituminous Paint: Cold applied asphalt emulsion complying with SSPC-Paint 12, containing no asbestos fibers, or cold applied asphalt emulsion complying with ASTM D 1187 ASTM D 1187/D 1187M.
7. Nonshrink, Nonmetallic Grout: Factory packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
8. Concrete Materials and Properties: Composed of ASTM C150 Type I Portland cement, ASTM C33 sand and coarse aggregates and potable water to produce a low slump mix suitable for placement. Grade coarse aggregate from 1/8” with at least 95 % passing a 3/8” sieve and not more than 10% passing a No. 8 sieve. Fill shall be proportioned to provide a minimum 28 day compressive strength of 3000 psi (20 MPa).

2.2 FABRICATION

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
1. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
2. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
3. Form exposed work with accurate angles and surfaces and straight edges.
4. Weld corners and seams continuously to comply with the following:
a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
b. Obtain fusion without undercut or overlap.
c. Remove welding flux immediately.
d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

5. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
6. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
7. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
8. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
9. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 inch by 1-1/2 inches (3.2 mm by 38 mm), with a minimum 6 inch (150 mm) embedment and 2 inch (50 mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

B. Miscellaneous Framing and Supports: Provide steel framing and supports necessary to complete the work and which are not a part of the structural framework, including but not limited to framing and supports for elevator hoistway beams, elevator sills, overhead lobby door frames, sliding doors, countertop and vanities, ceiling hung toilet compartments, and tube framing for partial height walls, CMU partition head supports, mechanical and electrical equipment.
1. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction. Cut, drill, and tap units to receive hardware, hangers, and similar items.
   a. Fabricate units from slotted channel framing where indicated.
   b. Furnish inserts for units installed after concrete is placed.

2. Operable Partitions: Fabricate supports for operable partitions from continuous steel beams of sizes recommended by partition manufacturer with attached bearing plates, anchors, and braces as recommended by partition manufacturer. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.
3. Framing for Ceiling Hung Toilet Compartments: Provide framing for ceiling hung toilet compartments, coordinated with the partitions and including provisions for partition anchorage as required to sustain imposed loads and to limit deflections to L/360 between hangers, fabricated from the following.
   a. Structural Steel Shapes, Plates and Bars: ASTM A36/A36M.
   b. Modular Structural Framing System: ASTM A569; modular, structural quality steel preformed U channel framing system with continuous open slot prepared to receive attachment nuts, bolts, straps, threaded rods, beam clamps, hanger rods support brackets and other accessories. Provide corrosion resistant finish.
   c. Provide steel rods, 1/2 inch (13 mm) diameter, spaced at maximum 36 inches (900 mm) o.c. Thread rods to receive anchor and stop nuts. Fit hangers with wedge shape washers for full bearing on sloping flanges of support beam.
   d. Coordinate installation with toilet compartment manufacturer's written instructions and recommendations.

4. Countertop and Vanity Framing: Custom fabricate countertop and vanity framing, using steel shapes and plates, and cold finished mild steel bars at exposed conditions, for support framing and plywood, to the thicknesses, sizes and shapes shown, and as

required to produce work of adequate strength and durability, without objectionable deflections. Use proven details of fabrication, as required, to achieve proper assembly and alignment of the various components of the work.

5. CMU Partition Head Supports: Fabricate supports from 4" x 4" x 1/4" x 36" (100 mm by 100 mm by 6 mm by 900 mm) long structural steel angles. Drill supports a maximum of 12 inches (300 mm) o.c. to receive expansion bolts.
6. Galvanize miscellaneous framing and supports at exterior locations; prime paint miscellaneous framing and supports at interior locations.
7. Steel Pipe Columns: Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.
    a. Unless otherwise indicated, fabricate from Schedule 40 steel pipe.
    b. Unless otherwise indicated, provide 1/2 inch (12.7 mm) baseplates with four 5/8 inch (16 mm) anchor bolts and 1/4 inch (6.4 mm) top plates.
    c. Galvanize miscellaneous framing and supports.

C. Shelf Angles: Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4 inch (19 mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c., unless otherwise indicated.
    1. Provide mitered and welded units at corners.
    2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches (50 mm) larger than expansion or control joint.
    3. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
    4. Galvanize and prime shelf angles located in exterior walls.
    5. Prime shelf angles located in exterior walls with zinc rich primer.
    6. Furnish wedge type concrete inserts, complete with fasteners, to attach shelf angles to cast in place concrete.

D. Ladders: Comply with ANSI A14.3. For elevator pit ladders, comply with ASME A17.1/CSA B44
    1. Steel Ladders:
        a. Space siderails 18 inches (457 mm) apart unless otherwise indicated.
        b. Siderails: Continuous, 1/2 inch by 2-1/2 inch (12.7 mm by 64 mm) steel flat bars, with eased edges.
        c. Rungs: 1 inch (25 mm) square steel bars.
        d. Fit rungs in centerline of siderails; plug weld and grind smooth on outer rail faces.
        e. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum oxide granules set in epoxy resin adhesive or by using a type of manufactured rung filled with aluminum oxide grout.
        f. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
            1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
                a) Harsco Industrial IKG, a division of Harsco Corporation.
                b) SlipNOT Metal Safety Flooring; W.S. Molnar Company.

        g. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted steel brackets.
        h. Galvanize ladders, including brackets and fasteners.

E. Ladder Safety Cages: Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless steel fasteners.
   1. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet (6 m) o.c. Provide secondary intermediate hoops spaced not more than 48 inches (1200 mm) o.c. between primary hoops.
   2. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless steel fasteners unless otherwise indicated.
   3. Steel Ladder Safety Cages:
      a. Primary Hoops: 1/4 inch by 4 inch (6.4 mm by 100 mm) flat bar hoops.
      b. Secondary Intermediate Hoops: 1/4 inch by 2 inch (6.4 mm by 50 mm) flat bar hoops.
      c. Vertical Bars: 3/16 inch by 1-1/2 inch (4.8 inch by 38 mm) flat bars secured to each hoop.
      d. Galvanize ladder safety cages, including brackets and fasteners.
      e. Prime ladder safety cages, including brackets and fasteners, with zinc rich primer.

2.3 ELEVATOR PIT SUMP COVERS

A. Elevator Pit Sump Covers: Fabricate from 3/16 inch (4.8 mm) plate with four 1 inch (25 mm) diameter holes for water drainage and for lifting.
   1. Fabricate from welded or pressure locked steel bar grating Limit openings in gratings to no more than 3/4 inch (19 mm) in least dimension.
   2. Provide steel angle supports as indicated.

2.4 MISCELLANEOUS STEEL TRIM

A. Miscellaneous Steel Trim: Unless otherwise indicated, fabricate units from structural steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
   1. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
      a. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction, spaced not more than 6 inches (150 mm) from each end, 6 inches (150 mm) from corners, and 24 inches (600 mm) o.c.

   2. Cast in Pit Angles and Edge Angles: Provide edge angles, and pit angles, fabricated from angles of size as shown, or required, with welded on stud anchors spaced 24 inches (600 mm) on center. Provide pit and edge angles in as long lengths as possible. Miter and weld corners and provide splice plates for alignment between sections.
   3. Galvanize miscellaneous steel trim.

2.5 PIPE BOLLARDS

A. Pipe Bollards: Fabricate metal bollards from Schedule 40 steel pipe or 1/4 inch (6.4 mm) wall thickness rectangular steel tubing.
   1. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
   2. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.
   3. Where installation on structural slab or existing paving.
   4. Fabricate bollards with 3/8 inch (9.5 mm) thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4 inch (19 mm) anchor bolts.

a. Where bollards are anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

5. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4 inch (6.4 mm) thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of bollard.

2.6 ABRASIVE METAL NOSINGS, TREADS AND THRESHOLDS

A. Cast Metal Units: Cast aluminum with an integral abrasive, as cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Safety Tread Co., Inc.
      b. Barry Pattern & Foundry Co., Inc.
      c. Granite State Casting Co.
      d. Safe-T-Metal Company, Inc.
      e. Wooster Products Inc.

   2. Nosings: Cross hatched units, 4 inches (100 mm) wide with 1 inch (25 mm) lip, for casting into concrete.
   3. Treads: Cross hatched units, full depth of tread with 3/4 inch by 3/4 inch (19 mm by19 mm) nosing, for application over bent plate treads or existing stairs.
   4. Thresholds: Fluted saddle type units, 5 inches (125 mm) wide by 1/2 inch (12 mm) high, with tapered edges.

B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

C. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches (100 mm) from ends and not more than 12 inches (300 mm) o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.
   1. Provide two rows of holes for units more than 5 inches (125 mm) wide, with two holes aligned at ends and intermediate holes staggered.

D. Apply bituminous paint to concealed surfaces of cast metal units.

E. Apply clear lacquer to concealed surfaces of extruded units.

2.7 LOOSE BEARING AND LEVELING PLATES

A. Loose Bearing and Leveling Plate: Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
   1. Galvanize plates.

2.8 LOOSE STEEL LINTELS

A. Loose Steel Lintels: Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

1. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches (200 mm) unless otherwise indicated.
2. Galvanize and prime loose steel lintels located in exterior walls.

2.9 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.10 FABRICATION TOLERANCES

A. Squareness: 1/8 inch (3mm) maximum difference in diagonal measurements.

B. Maximum Offset Between Faces: 1/16 inch (1.5mm).

C. Maximum Misalignment of Adjacent Members: 1/16 inch (1.5mm).

D. Maximum Bow: 1/8 inch (3mm) in 48 inches (1.2m).

E. Maximum Deviation From Plane: 1/16 inch (1.5mm) in 48 inches (1.2m).

2.11 FINISHES

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surfaces.

2.12 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonr-------[y, or unless otherwise indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 3, "Power Tool Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

F. Stainless Steel Finishes: Remove tool and die marks and stretch lines or blend into finish.
   1. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
   2. Bright, Directional Polish: No. 4 finish.
   3. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
   1. Cast Aluminum: Heavy coat of bituminous paint.
   2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for ceiling hung toilet partitions, operable partitions, overhead doors and overhead grilles securely to, and rigidly brace from, building structure.
   1. Ceiling Hung Toilet Partitions: Anchor supports securely to, and rigidly brace from, overhead building structure.

2. CMU Partition Head Supports: Unless otherwise indicated place partition head supports on alternate faces of CMU partitions every 6 feet o.c. and expansion bolt to underside of structure. Do not bolt to CMU partitions.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING METAL BOLLARDS

A. Fill metal capped bollards solidly with concrete and allow concrete to cure seven days before installing.
1. Do not fill removable bollards with concrete.

3.4 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

A. Center nosings on tread widths unless otherwise indicated.

B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 079200 "Joint Sealants" to provide a watertight installation.

3.5 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.1 ERECTION TOLERANCES

A. Maximum Variation from Plumb: 1/4 inch (6mm) per story, noncumulative.

B. Maximum Offset from True Alignment: 1/4 inch (6mm).

C. Maximum Out of Position: 1/4 inch (6mm).

3.2 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop painted surfaces.
   1. Apply by brush or spray to provide a minimum 2.0 mil (0.05 mm) dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099000.

Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION

SECTION 06 10 53
MISCELLANEOUS ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTIONS INCLUDES

A. Preservative-treated wood materials.

B. Fire-retardant-treated wood materials.

C. Communications and electrical room mounting boards.

D. Concealed wood blocking, nailers, and supports.

1.02 REFERENCE STANDARDS

A. APA E30 - Engineered Wood Construction Guide.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. AWPA U1 - Use Category System: User Specification for Treated Wood.

E. ITS (DIR) - Directory of Listed Products.

F. PS 1 - Structural Plywood.

G. PS 20 - American Softwood Lumber Standard.

H. SPIB (GR) - Standard Grading Rules.

I. UL (DIR) - Online Certifications Directory.

1.03 SUBMITTALS

A. Product Data:
   1. Fire-retardant treatment.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Cover wood products to protect against moisture. Support stacked products to prevent deformation and allow air circulation.

B. Fire-Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
   1. Species: Southern Pine, unless otherwise indicated.
   2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org), and that provides grading service for species and grade specified. Provide lumber stamped with grade mark unless otherwise indicated.

2.02 DIMENSION LUMBER

A. Grading Agency: Southern Pine Inspection Bureau, Inc; SPIB (GR).

B. Sizes: Nominal sizes as indicated on drawings, S4S.

C. Moisture Content: S-dry or MC19.

D. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
   1. Lumber: S4S, No.2 or Standard Grade.
   2. Boards: Standard or No.3.

2.03 CONSTRUCTION PANELS

A. Communications and Electrical Room Mounting Boards: PS 1, A-D plywood; 3/4 inch thick; fire-retardant treated.

2.04 FIRE-RETARDANT TREATMENT (FRT)

A. Factory-treat wood members in accordance with AWPA U1 and use category indicated.

B. Fire-Retardant Treatment: Interior Type A, Use Category UCFA (LT), Low-Temperature (low hygroscopic).
   1. Treat electrical and communications panel backer boards.

C. Kiln-dry after treatment (KDAT) to maximum moisture content of 19 percent for sawn material and 15 percent for plywood.

D. Fabrication of FRT Wood:
   1. Ripping or milling of boards, lumber, and timber after treatment is not permitted.
   2. Field cutting to length and drilling of holes in boards, lumber, and timber are permitted without additional treatment.
   3. Field cutting and drilling of holes in plywood are permitted.

E. Label or brand FRT wood with classification mark of UL (DIR) or ITS (DIR) or other approved inspection agency, the treatment plant, name of treatment, species of wood, flame spread and smoke-developed indexes, method of drying after treatment, and treating standard.

2.05 ACCESSORIES

A. Metal and Finish of Fasteners:
   1. Fire-Retardant-Treated Wood:
      a. Nails, timber rivets, wood screws, and lag screws: Hot-dip galvanized steel complying with ASTM A153/A153M Class D.
   2. Untreated Wood: Unfinished steel.
   3. Metal and Finish: Hot-dip galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
   4. Anchors: Toggle bolt type for anchorage to hollow masonry.

2.06 FACTORY WOOD TREATMENT

A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
   1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
   2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

B. Fire Retardant Treatment:
   1. Interior Type A: AWPA U1, Use Category UCFA, Commodity Specification H, low temperature, low hygroscopic type, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
      a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
      b. Treat rough carpentry items as indicated.
      c. Do not use treated wood in applications exposed to weather or where the wood may become wet.

C. Preservative Treatment:

1. Preservative Pressure Treatment of Lumber Above Grade: AWPA U1, Use Category UC3B, Commodity Specification A using waterborne preservative to 0.10 lb/cu ft retention.
    a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
    b. Treat lumber exposed to weather.
    c. Treat lumber in contact with roofing, flashing, or waterproofing.
    d. Treat lumber in contact with masonry or concrete.
    e. Treat lumber less than 18 inches above grade.
    f. Treat lumber in other locations as indicated.

PART 3 EXECUTION

3.01 PREPARATION

A. Coordinate installation of rough carpentry members specified in other sections.

3.02 INSTALLATION - GENERAL

A. Select material sizes to minimize waste.

B. Reuse scrap to greatest extent possible; clearly separate scrap for use on-site as accessory components, including shims, bracing, and blocking.

C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.03 BLOCKING, NAILERS, AND SUPPORTS

A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.

B. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.

C. In walls, provide blocking attached to studs as backing and support for wall-mounted items unless item can be securely fastened to two or more studs or another method of support is explicitly indicated.

D. Where ceiling mounting is indicated, provide blocking and supplementary supports above ceiling unless another method of support is explicitly indicated.

E. Provide the following specific nonstructural framing and blocking:
    1. Cabinets and shelf supports.
    2. Grab bars.
    3. Towel and bath accessories.
    4. Chalkboards and marker boards.

3.04 INSTALLATION OF CONSTRUCTION PANELS

A. Construction Panels - General: Install in accordance with APA E30.

B. Communications and Electrical Room Mounting Boards: Secure with screws to studs; space fasteners at maximum 24 inches on center.
    1. At fire-rated walls, install board over wallboard indicated as part of fire-rated assembly.
    2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
    3. Install adjacent boards without gaps.
    4. Size and Location: As indicated on drawings.

3.05 CLEANING

A. Do not leave wood, shavings, sawdust, etc. on ground or buried in fill.

B. Prevent sawdust and wood shavings from entering storm drainage system.

END OF SECTION

SECTION 06 41 00
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Specially fabricated cabinet units.

B. Hardware.

C. Preparation for installing utilities.

1.02 REFERENCE STANDARDS

A. ANSI A135.4 - Basic Hardboard.

B. ASTM F547 - Standard Terminology of Nails for Use with Wood and Wood-Base Materials.

C. AWI (QCP) - Quality Certification Program.

D. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition.

E. BHMA A156.9 - Cabinet Hardware.

F. NEMA LD 3 - High-Pressure Decorative Laminates.

G. PS 20 - American Softwood Lumber Standard.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a preinstallation meeting not less than one week before starting work of this section; require attendance by all affected installers.

1.04 SUBMITTALS

A. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
   1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.
   2. Provide information as required by AWI/AWMAC/WI (AWS).
   3. Include certification program label.

B. Product Data: Provide data for hardware accessories.

C. Samples:
   1. Plastic laminate: Color/pattern, two, 12 x 12 inch.
   2. PVC edging: Two each color, 6 inch long.

1.05 QUALITY ASSURANCE

A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
   1. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.

B. Quality Certification:
   1. Comply with AWI (QCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.awiqcp.org/#sle.
   2. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) requirements for grade or grades specified.
   3. Provide designated labels on shop drawings as required by certification program.
   4. Provide designated labels on installed products as required by certification program.
   5. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.
   6. Replace, repair, or rework all work for which certification is refused.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect units from moisture damage.

1.07 FIELD CONDITIONS

A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 CABINETS

A. Quality Standard: Premium Grade, in accordance with AWI/AWMAC/WI (AWS), unless noted otherwise.

B. Cabinets:
   1. Finish - Exposed Exterior Surfaces: As indicated on drawings.
   2. Finish - Exposed Interior Surfaces: As indicated on drawings.
   3. Finish - Semi-Exposed Surfaces: As indicated on drawings
   4. Finish - Concealed Surfaces: Manufacturer's option.
   5. Door and Drawer Front Edge Profiles: As indicated on drawings.
   6. Door and Drawer Front Retention Profiles: Fixed panel.
   7. Casework Construction Type: Type A - Frameless.
   8. Interface Style for Cabinet and Door: Style 1 - Overlay; reveal overlay.
   9. Adjustable Shelf Loading: 50 psf.
   10. Drawer Side Construction: Multiple-dovetailed.
   11. Drawer Construction Technique: Dovetail joints.

2.02 WOOD-BASED COMPONENTS

A. Wood fabricated from old growth timber is not permitted.

2.03 LUMBER MATERIALS

A. Softwood Lumber: PS 20 Graded in accordance with AWI/AWMAC/WI (AWS), Grade I/Premium; moisture content of maximum 12 percent; species as recommended by manufacturer.

2.04 PANEL CORE MATERIALS

A. Basic Hardboard: Panel manufactured from inter-felted lignocellulosic fibers consolidated under heat and pressure; comply with ANSI A135.4.
   1. Surface: Smooth one side (S1S).

2.05 LAMINATE MATERIALS

A. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.

B. Provide specific types as indicated.
   1. Horizontal Surfaces: HGS, 0.048 inch nominal thickness, colors as indicated, finish as indicated.
   2. Vertical Surfaces: VGS, 0.028 inch nominal thickness, through color, colors as indicated, finish as indicated.
   3. Cabinet Liner: CLS, 0.020 inch nominal thickness, through color, colors as indicated, finish as indicated.
   4. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

2.06 COUNTERTOPS

A. Countertops: See Section 12 36 00.

2.07 ACCESSORIES

A. Adhesive: Type recommended by fabricator to suit application.

B. Aluminum Trim and Mouldings: Extruded, alloy 6063 T5.
   1. Type: Profile as selected from manufacturer's standard range.
   2. Finish: As selected.

C. Fasteners: Size and type to suit application.

D. Nails: ASTM F547, size and type to suit application.

E. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; non-corrosive finish in concealed locations and stainless steel finish in exposed locations.

F. Concealed Joint Fasteners: Threaded steel.

G. Screw Caps: Snap-on plastic caps to conceal screw head. Color: White.

H. Grommets: Standard plastic grommets for cut-outs, in color as scheduled.

2.08 HARDWARE

A. Cabinet Hardware: Comply with BHMA A156.9 for hardware types and grades indicated below:
   1. Hardware Types: As indicated on drawings.
   2. Product Grade: Grade 2.

B. Adjustable Shelf Supports: Standard side-mounted system using multiple holes for pin supports and coordinated self rests, polished chrome finish, 1/4 inch diameter holes for nominal 2 inch spacing adjustments.

C. Countertop Brackets: Cantilevered support legs with wall header, face-of-wall mounting.
   1. Materials: Steel angles.
   2. Finish: Manufacturer's standard, factory-applied, powder coat.
   3. Color: Black.

D. Drawer and Door Pulls: "U" shaped wire pull, steel with chrome finish, 4 inch centers.

E. Drawer Slides:
   1. Type: Full extension.
   2. Static Load Capacity: Commercial grade.
      a. Pencil Drawer, 45 lb. load rating.
      b. Box Drawer, 100 lb. load rating.
      c. File Drawer, 200 lb. load rating.
   3. Mounting: Side mounted.
   4. Stops: Integral type.
   5. Features: Provide self closing/stay closed type.
   6. Manufacturers:
      a. Accuride International, Inc: www.accuride.com/#sle.
      b. Blum, Inc: www.blum.com/#sle.
      c. Knape & Vogt Manufacturing Company: www.knapeandvogt.com/#sle.

F. Hinges: European style concealed self-closing type, steel with polished finish.
   1. Capable of 3-way adjustment, 165-170 degree opening.
   2. Manufacturers:
      a. Blum, Inc: www.blum.com/#sle.
      b. Grass America Inc: www.grassusa.com/#sle.
      c. Hafele America Co: www.hafele.com/us
      d. Salice America, Inc: www.saliceamerica.com

2.09 FABRICATION

A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.

B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.

C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.

D. Use exposed fastening devices or nails only when unavoidable. Arrange neatly.

E. Shelf Support Type: One of the following methods, Contractor's Option. Use specific method when indicated on drawings.
   1. Bored-hole and pin shelf support system.
   2. Metal standard and clip support system.

F. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.
   1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.

G. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify adequacy of backing and support framing.

3.02 INSTALLATION

A. Install work in accordance with AWI/AWMAC/WI (AWS) requirements for grade indicated.

B. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.

C. Use fixture attachments in concealed locations for wall mounted components.

D. Use concealed joint fasteners to align and secure adjoining cabinet units.

E. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.

F. Secure cabinets to floor using appropriate angles and anchorages.

G. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.
   1. Install plastic screw caps to conceal screw heads at cabinet mounting fasteners.

3.03 ADJUSTING

A. Adjust installed work.

B. Adjust moving or operating parts to function smoothly and correctly.

3.04 CLEANING

A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION

SECTION 07 21 00
THERMAL INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Board insulation at cavity wall construction, over roof deck, and locations indicated.

B. Batt insulation in exterior wall and ceiling construction.

C. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.

1.02 DEFINITIONS

A. Mineral Fiber Material Composition: Insulation referred to as mineral fiber block, board, and blanket insulation is composed of fibers from mineral based substances such as rock, slag, or glass and processed from the molten state into fibrous form.

1. Based on type of insulation substance, the material will be referred to as a mineral fiber when having a rock or slag base, and glass fiber with a glass or silica sand base, also considered a mineral.
2. Insulation blankets are flexible units consisting of felted, bonded, or unbonded fibers formed into rolls or flat cut pieces referred to as batts; rolls are simply longer versions of batts.
3. For additional information about mineral fiber and the various classification types, refer to the following reference standards; ASTM C553, ASTM C612, ASTM C665, and ASTM C726.

1.03 REFERENCE STANDARDS

A. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

B. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

C. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

D. ASTM C726 - Standard Specification for Mineral Wool Roof Insulation Board.

E. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

G. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C.

1.04 SUBMITTALS

A. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

B. Manufacturer's Installation Instructions: Include information on installation techniques.

C. ABAA Manufacturer Qualification: Submit documentation of current evaluation of proposed manufacturer and materials.

1.05 QUALITY ASSURANCE

A. Air Barrier Association of America (ABAA) Evaluated Materials Program (EAP); www.airbarrier.org/#sle: Use evaluated materials from a single manufacturer regularly engaged in air barrier material manufacture. Use secondary materials approved in writing by primary material manufacturer.

1.06 FIELD CONDITIONS

A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 PRODUCTS

2.01 FOAM BOARD INSULATION MATERIALS

A. Polyisocyanurate (ISO) Board Insulation: Rigid cellular foam, comply with ASTM C1289.
   1. Classifications:
      a. Type I: Faced with aluminum foil on both major surfaces of the core foam.
         1) Class 2 - Glass fiber reinforced or non-reinforced core foam.
         2) Compressive Strength: 16 psi, minimum.
         3) Thermal Resistance, R-value: At 1-1/2 inch thick; 9.0, minimum, at 75 degrees F.
   2. Board Thickness: As indicted on Drawings.
   3. Tapered Board: Slope as indicated; minimum thickness 1/4 inch; fabricate of fewest layers possible.
   4. Board Edges: Square.
   5. Products:
      a. Atlas Roofing Corporation: www.atlasroofing.com/#sle.
      b. Carlisle Coatings & Waterproofing, Inc: www.carlisleccw.com/#sle.
      c. Firestone Building Products
      d. GAF: www.gaf.com/#sle.
      e. InsulFoam LLC: www.insulfoam.com/#sle.
      f. Johns Manville: www.jm.com/#sle.

2.02 MINERAL FIBER BLANKET INSULATION MATERIALS

A. Flexible Glass Fiber Blanket Thermal Insulation: Preformed insulation, complying with ASTM C665; friction fit.
   1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
   2. Smoke Developed Index: 50 or less, when tested in accordance with ASTM E84.
   3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
   4. Thermal Resistance: As indicated on drawings.
   5. Facing: Asphalt treated Kraft paper, one side.
   6. Products:
      a. CertainTeed Corporation: www.certainteed.com/#sle.
      b. Johns Manville: www.jm.com/#sle.
      c. Knauf Insulation: www.knaufinsulation.com/#sle.
      d. Owens Corning Corporation: www.ocbuildingspec.com/#sle.

B. Mineral Wool Blanket Thermal Insulation: Flexible or semi-rigid preformed insulation, complying with ASTM C665.
   1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
   2. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.
   3. Thermal Resistance: As indicated on drawings.
   4. Products:
      a. Johns Manville: www.jm.com/#sle.
      b. Knauf Insulation: www.knaufinsulation.com/#sle.
      c. ROCKWOOL (ROXUL, Inc): www.rockwool.com/#sle.
      d. Thermafiber, Inc: www.thermafiber.com/#sle.

2.03 ACCESSORIES

A. Tape: Bright aluminum self-adhering type, mesh reinforced, 2 inch wide.

B. Insulation Fasteners: Appropriate for purpose intended.
   1. Length as required for thickness of insulation material and penetration of deck substrate.
C. Wire Mesh: Galvanized steel, hexagonal wire mesh.
D. Adhesive: Type recommended by insulation manufacturer for application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 BOARD INSTALLATION AT CAVITY WALLS

A. Apply adhesive to back of boards:
   1. Three continuous beads per board length.
   2. Full bed 1/8 inch thick.
B. Install boards to fit snugly between wall ties.
C. Install boards horizontally on walls.
   1. Place boards to maximize adhesive contact.
   2. Install in running bond pattern.
   3. Butt edges and ends tightly to adjacent boards and protrusions.
D. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BOARD INSTALLATION USING CLADDING AND CONTINUOUS INSULATION SUPPORTS

A. Install supports in accordance with manufacturer's installation instructions.
B. Install supports in compliance with system orientation, sizes, and locations as indicated on drawings and in accordance with approved shop drawings.
C. Install supports to fill in exterior wall spaces without gaps or voids in insulation.
D. Trim insulation neatly to fit spaces and provide a continuous thermal layer.

3.04 BATT INSTALLATION

A. Install insulation in accordance with manufacturer's instructions.
B. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.
C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
E. Retain insulation batts in place with wire mesh secured to framing members.
F. Tape seal butt ends, lapped flanges, and tears or cuts in membrane.
G. Coordinate work of this section with construction of air barrier seal, see Section 07 27 00.

3.05 FIELD QUALITY CONTROL

A. Coordination of Air Barrier Association of America (ABAA) Tests and Inspections:
   1. Provide testing and inspection required by ABAA Quality Assurance Program (QAP).
   2. Notify ABAA in writing of schedule for air barrier work, and allow adequate time for testing and inspection.
   3. Cooperate with ABAA testing agency.
   4. Allow access to air barrier work areas and staging.
   5. Do not cover air barrier work until tested, inspected, and accepted.

3.06 PROTECTION

A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION

SECTION 07 27 26
FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 GENERAL

1.01 REFERENCES

A. Reference Standards: Comply with the most recent published edition of the following standards, except where a specific edition is cited herein.

B. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

D. ASTM C1193 - Standard Guide for Use of Joint Sealants.

E. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.

F. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.

G. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating.

H. ASTM D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

I. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.

J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.

K. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.

L. ASTM E779 - Standard Test Method for Determining Air Leakage Rate by Fan Pressurization.

M. ASTM E1186 - Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.

N. ASTM E1827 - Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door.

O. ASTM E2178 - Standard Test Method for Air Permeance of Building Materials.

P. ASTM E2357 - Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.

Q. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components.

1.02 DEFINITIONS

A. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.

B. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

C. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

2. Schedule conference, two weeks prior to start of air barrier installation. Attendees shall include Contractor, certified installer, and air barrier manufacturer’s representative. Optional attendees Owner’s representative and Architect.

1.04 SUBMITTALS

A. Product Data: For each type of product.
   1. Include manufacturer's written instructions for evaluating, preparing, and treating each substrate; technical data; dry film thickness; and tested physical and performance properties of products.

B. Shop Drawings: For air-barrier assemblies.
   1. Show locations and extent of air-barrier materials, accessories, and assemblies specific to Project conditions.
   2. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
   3. Include details of interfaces with other materials that form part of air barrier.

C. Qualification Data: For Installer. Include list of ABAA-certified installers and supervisors employed by Installer, who work on Project.

D. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.

E. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

F. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
   1. Installer to be licensed by ABAA in accordance with ABAA's Quality Assurance Program and to employ ABAA-certified installers and supervisors on Project.

B. Mockups: Build mockups to set quality standards for materials and execution and for preconstruction testing.
   1. Build integrated mockups of exterior wall assembly as indicated on Drawings but not less than 150 sq. ft., incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
      a. Coordinate construction of mockups to permit inspection and testing of air barrier before external insulation and cladding are installed.
      b. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
      c. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

C. Preconstruction Testing
   1. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform preconstruction testing on field mockups.
   2. Mockup Testing: Air-barrier assemblies must comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.

a. Air-Leakage-Location Testing: Mockups will be tested for evidence of air leakage in accordance with ASTM E1186, chamber pressurization or depressurization with smoke tracers.
b. Air-Leakage-Volume Testing: Mockups will be tested for air-leakage rate in accordance with ASTM E2357.
c. Adhesion Testing: Mockups will be tested for required air-barrier adhesion for a minimum of 30 lbf/sq. to substrate in accordance with ASTM D4541.
d. Notify Architect seven days in advance of the dates and times when mockups will be tested.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and products in labeled packages. Store and handle in strict compliance with manufacturer’s instructions and recommendations. Protect from damage, weather, excessive temperatures, freezing or extreme heat, and construction operations. Remove damaged material from site and dispose of in accordance with applicable regulations. Remove and replace liquid materials that cannot be applied within their stated shelf life.

B. Remove and replace liquid materials that cannot be applied within their stated shelf life.

C. Protect stored materials from direct sunlight.

1.07 FIELD CONDITIONS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.
   1. Protect substrates from environmental conditions that affect air-barrier performance.
   2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

1.08 WARRANTY

A. System Warranty: Manufacturer’s shall warranty system including the primary air barrier and installed accessories, sealants and sheet materials to be free from defects in material and workmanship, and agreeing to replace defective materials and components.
   1. Warranty Period: Thirty (30) years from date of Substantial Completion.

B. Installer's Warranty: Waterproofing System Installer's Warranty: Submit waterproofing system installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section.
   1. Warranty Period: Five (5) years from date of Substantial Completion.

C. Air-barrier manufacturer to be affiliated with the roofing system manufacturer specified in Section 07 52 00, to provide unified building-envelope warranty coverage.

PART 2 PRODUCTS

2.01 PERFORMANCE CRITERIA

A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction to be capable of performing as a continuous vapor-permeable air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Building envelope air leakage: ASTM E779 or ASTM E1827, < 0.40 cfm/ft2 (2.0 L/s·m2) of the building thermal envelope area at a pressure differential of 0.3 inch water gauge (75 Pa).

C. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (equal to 0.2 L/s. x sq. m. at 75 Pa), when tested in accordance with ASTM E2357.

1. Assembly shall accommodate movements of building materials by providing expansion and control joints as required, with accessory air and vapor seal materials at such locations, changes in substrate and perimeter conditions.
    a. Assembly shall be capable of withstanding combined positive and negative design wind, fan and stack pressures on the envelope without damage or displacement, and shall transfer the load to the structure.
    b. Assembly shall not displace adjacent materials under full load.
    c. Assembly shall be joined in an airtight and flexible manner to the air barrier material of adjacent assemblies, allowing for the relative movement of assemblies due to thermal and moisture variations and creep, and anticipated seismic movement.

D. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. pressure difference; ASTM E2178.

E. Ultimate Elongation: Minimum 200 percent; ASTM D412, Die C.

F. Adhesion to Substrate: tested in accordance with ASTM D4541.

G. Fire Propagation Characteristics: Basis-of-Design product is part of an approved wall assembly that passes NFPA 285 testing as part of an approved assembly. Do not submit comparable products without coordination of compliance.

H. UV Resistance: Can be exposed to sunlight for maximum of 12 months in accordance with manufacturer's written instructions.

2.02 FLUID-APPLIED AIR BARRIERS, VAPOR PERMEABLE

A. Fluid-Applied, Vapor-Permeable Air Barrier, Synthetic Polymer Type: Synthetic polymer membrane for above-grade wall assemblies with an installed dry film thickness, according to manufacturer's written instructions, of approximately 20 mils in a single coat over smooth, void-free substrates.
    1. Basis-of-Design Product: Subject to compliance with requirements, provide by GMX; Air Guard HVWZ (James Roberts; jroberts@garlandco.com; 832-525-8079) or comparable product by one of the following:
        a. GCP Applied Technologies; Perm-A-Barrier VPL
        b. Carlisle Coatings & Waterproofing, Inc.
        c. Henry Company, Sealants Division.

B. Vapor Permeance: Minimum 10 perms; ASTM E96/E96M, Procedure B, Water Method.

2.03 ACCESSORIES

A. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal. Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier material.

B. Primer: Liquid primer recommended for substrate by air-barrier material manufacturer.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, 0.0187 inch thick, and Series 300 stainless steel fasteners.

D. Counterflashing Strip: Modified bituminous Non-asphaltic, 40-mil-thick, self-adhering sheet consisting of 32 mils of rubberized asphalt laminated to an 8-mil-thick, cross-laminated polyethylene film with release liner backing.

E. Interface With Adjacent Materials: Provide the following transition strips as applicable to suit conditions and maintain continuity of air barrier:
    1. Counterflashing: As recommended by air barrier Manufacturer.

2. Roof flashing: As recommended and approved in writing by both the air barrier and the roof membrane Manufacturers. Submit a coordinated detail for review by Architect.

F. Butyl Strip: Vapor retarding, 30 to 40 mils thick, self-adhering; polyethylene-film-reinforced top surface laminated to layer of butyl adhesive with release liner backing.

G. Modified Bituminous Strip: Vapor retarding, 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil-thick polyethylene film with release liner backing.

H. Joint Reinforcing Strip: Air-barrier manufacturer's glass-fiber-mesh tape.

I. Substrate-Patching Membrane: Manufacturer's standard trowel-grade substrate filler.

J. Joint Reinforcing Strip (If required by air barrier Manufacturer): Air-barrier manufacturer's standard joint reinforcing material(s) or sealants.

K. Substrate-Patching Material: Substrate fillers for preparation of cracks and overdriven fasteners, as recommended by air barrier manufacturer.

L. Adhesive and Tape: Air-barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.

M. Sprayed Polyurethane Foam Sealant: One- or two-component, foamed-in-place, polyurethane foam sealant, 1.5- to 2.0-lb/cu. ft density; flame-spread index of 25 or less according to ASTM E162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.

N. Modified Bituminous Transition Strip: Vapor retarding, 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil-thick polyethylene film with release liner backing.

O. Elastomeric Flashing Sheet: ASTM D2000, minimum 50- to 65-mil-thick, cured sheet neoprene with manufacturer-recommended contact adhesives and lap sealant with stainless-steel termination bars and fasteners.

P. Preformed Silicone Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.

Q. Joint Sealant: ASTM C920, single-component, neutral-curing silicone; Class 100/50 (low modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Section 07 92 00 "Joint Sealants." Air Guard HVWZ Liquid Flashing or air-barrier manufacturer's approved compatible sealant or liquid flashing.

R. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.

S. Sheathing Joint Sealant: Single or multi-component, moisture curing, low-modulus, high-movement polyether / silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing and air barrier manufacturer for application indicated.

1. Comply with ASTM C920 and other requirements for each liquid-applied chemically curing sealant, including those referencing ASTM C920 classifications for type, grade, class, and uses related to exposure and joint substrates.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.

2. Verify that substrates have cured and aged for minimum time recommended in writing by air-barrier manufacturer.
3. Verify that substrates are visibly dry and free of moisture. Test concrete substrates for capillary moisture by plastic sheet method in accordance with ASTM D4263.
4. Verify that masonry joints are flush and completely filled with mortar.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate in accordance with manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.

B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.

E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

H. Bridge expansion joints discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement in accordance with manufacturer's written instructions and details.

3.03 JOINT TREATMENT

A. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C1193 and air-barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D4258 before coating surfaces.
1. Prime substrate and apply a single thickness of air-barrier manufacturer's recommended preparation coat extending a minimum of 3 inches along each side of joints and cracks. Apply a double thickness of fluid air-barrier material and embed a joint reinforcing strip in preparation coat.

B. Gypsum Sheathing: Fill joints greater than 1/4 inch with sealant according to ASTM C1193 and air-barrier manufacturer's written instructions. Apply first layer of fluid air-barrier material at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air-barrier material over joint reinforcing strip.

3.04 INSTALLATION OF ACCESSORIES (TRANSITION STRIP INSTALLATION)

A. Install strips, transition strips, and accessory materials in accordance with air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.
1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
3. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.

4. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
5. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.

B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

C. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.

D. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

E. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply modified bituminous transition strip adhesive-coated transition, or preformed silicone-sealant extrusion so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames, with not less than 1 inch of full contact.
1. Transition Strip: Roll firmly to enhance adhesion.
2. Adhesive-Coated Transition Strip: Roll firmly to enhance adhesion.
3. Elastomeric Flashing Sheet: Apply adhesive to wall, frame, and flashing sheet. Install flashing sheet and termination bars, fastened at 6 inches o.c. Apply lap sealant over exposed edges and on cavity side of flashing sheet.
4. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.
5. Flashing Sheet: Apply adhesive to wall, frame, and flashing sheet. Install flashing sheet and termination bars, fastened at 6 inches o.c. Apply lap sealant over exposed edges and on cavity side of flashing sheet.
6. Silicone Sheets Transition Assemblies: Set in full bed of silicone sealant applied to walls, door and window frames, and air-barrier material.

F. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material as recommended by air barrier manufacturer.

G. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.

H. Seal top of through-wall flashings to air barrier with an additional 6-inch-wide, transition strip.
1. Counterflashing strip for metal flashings.
2. Modified bituminous strip for nonmetallic flashings.

I. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

J. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.

3.05 INSTALLATION OF FLUID AIR-BARRIER MEMBRANE

A. Apply fluid air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier in accordance with air-barrier manufacturer's written instructions and details. Apply air-barrier material within manufacturer's recommended application temperature ranges.
1. Apply air barrier membrane primers within manufacturer's recommended application temperature ranges and recommendations (If required by air barrier Manufacturer).

2. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
3. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
4. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.

B. Membrane Air Barriers: Apply continuous unbroken air-barrier membrane to substrates according to the following thickness. Apply air-barrier material in full contact around protrusions such as masonry ties.
1. Vapor-Permeable, Fluid-Applied Air Barrier: Total dry film thickness as recommended in writing by manufacturer to comply with performance requirements, but approximately 20 mils in a single coat where Air Guard HVWZ is used. Apply additional material only as needed to achieve complete, void- and pinhole-free coverage without exceeding the thickness on which required vapor permeability is based.

C. Apply strip and transition strip a minimum of 1 inch onto cured air-barrier material or strip and transition strip over cured air-barrier material overlapping 3 inches onto each surface according to air-barrier manufacturer's written instructions.

D. Do not cover air barrier until it has been tested and inspected by testing agency.

E. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.06 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Manufacturer Services:
1. Manufacturer’s Field Representative: An authorized, full time employee of the applicable system manufacturer shall be assigned to the Project to conduct field observations during the installation phase for the Work within the manufacturer’s scope.
2. Manufacturer's Representative must be on site during installation of the air barrier.
3. Regularly scheduled site observations shall be required by the manufacturer’s field representative a minimum of 3 days per week during the applicable installation period. Exceptions may be made for inclement weather, holidays, and similar conditions.
4. Observation reports shall include the following.
a. Written report documenting installation progress at the time of the site visit, delivered electronically to the Architect and Owner within 48 hours of the site visit.
b. Documentation of issues and questions observed, and the corresponding resolution or current status.
c. Record of directives and field guidance provided to the Contractor and installer.
d. Digital photographic documentation of installation progress, including specific issues and areas of concern.
e. Project name, Architect’s project number, and the date, time, and duration of the site visit.
5. In addition to progress observations, the manufacturer’s representative shall do the following.
a. Attend the applicable trade start up meeting.
b. Inspect and approve the applicable substrate, deck, wall sheathing, backup wall assembly, or foundation condition, as applicable, prior to the start of the manufacturer’s Work.

6. All observation reports shall be kept current and shall be delivered electronically to the Architect and Contractor within 5 calendar days after the observation. Progress payments for applicable Work may be withheld if observation report submissions are not current.
7. After completion of the manufacturer's Work, and prior to acceptance of the installation, the manufacturer's representative shall conduct a final observation to document all Work requiring corrective action as a condition of acceptance.
    a. Each item requiring corrective work shall be identified, including specific location, and the required corrective action shall be noted.
    b. The final observation report shall be produced in writing with photographic documentation. Marking corrective items on the installed Work alone shall not be acceptable.
8. The manufacturer's field representative shall provide a web-based project log for all field observations and photographic documentation associated with the Work. This log shall serve as the central record of manufacturer field observation activity and shall include observation reports and associated photographic documentation for each site visit. Photographs shall be cataloged with general project location.

D. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Air-barrier dry film thickness.
3. Continuous structural support of air-barrier system has been provided.
4. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
5. Site conditions for application temperature and dryness of substrates have been maintained.
6. Maximum exposure time of materials to UV deterioration has not been exceeded.
7. Surfaces have been primed, if applicable.
8. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
9. Termination mastic has been applied on cut edges.
10. Strips and transition strips have been firmly adhered to substrate.
11. Compatible materials have been used.
12. Transitions at changes in direction and structural support at gaps have been provided.
13. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
14. All penetrations have been sealed.

E. Tests: As determined by testing agency from among the following tests:
1. Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage in accordance with ASTM E1186, chamber pressurization or depressurization with smoke tracers.
2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate in accordance with ASTM E2357.
3. Adhesion Testing: Air-barrier assemblies will be tested for minimum air-barrier adhesion of 30 lbf/sq. in accordance with ASTM D4541 for each 600 sq. ft. of installed air barrier or part thereof.

F. Air barriers will be considered defective if they do not pass tests and inspections.
1. Apply additional air-barrier material, in accordance with manufacturer's written instructions, where inspection results indicate insufficient thickness, incomplete coverage, or pinholes.

2. Remove and replace deficient air-barrier components for retesting as specified above.

G. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

H. Prepare test and inspection reports.

3.07 CLEANING AND PROTECTION

A. Protect air-barrier system from damage during application and remainder of construction period, in accordance with manufacturer's written instructions.
   1. Protect air barrier from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for more than 12 months, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed materials in accordance with air-barrier manufacturer's written instructions.
   2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.

B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

C. Remove masking materials after installation.

END OF SECTION

SECTION 07 42 13
METAL WALL PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured metal panels for exterior wall panels and subgirt framing assembly, with related flashings and accessory components.

1.02 REFERENCE STANDARDS

A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).

B. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum.

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

D. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components.

1.03 SUBMITTALS

A. Product Data - Wall System: Manufacturer's data sheets on each product to be used, including:
   1. Physical characteristics of components shown on shop drawings.
   2. Storage and handling requirements and recommendations.
   3. Installation instructions and recommendations.

B. Shop Drawings: Indicate dimensions, layout, joints, construction details, support clips, and methods of anchorage.

C. Samples: Submit two samples of wall panel, 6 inches by 6 inches in size illustrating finish color, sheen, and texture.

D. Test Reports: Submit test report verifying compliance with NFPA 285 for previously-tested exterior wall assembly.

E. Manufacturer's qualification statement.

F. Installer's qualification statement.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in installing products specified in this section with minimum three years of documented experience.

C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.

B. Store prefinished material off the ground and protected from weather; prevent twisting, bending, or abrasion; provide ventilation; slope metal sheets to ensure proper drainage.

C. Prevent contact with materials that may cause discoloration or staining of products.

1.06 FIELD CONDITIONS

A. Do not install wall panels when air temperature or relative humidity are outside manufacturer's limits.

1.07 WARRANTY

A. Finish Warranty: Provide 15-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Wall Panels - Concealed Fasteners:
   1. MAC Architectural Metals, a Cornerstone Building Brands Company: www.macmetalarchitectural.com/#sle.
   2. Other manufacturers approved by Architect.

2.02 METAL WALL PANEL SYSTEM

A. Wall Panel System: Factory fabricated prefinished metal panel system, site assembled.
   1. Provide exterior wall panels and subgirt framing assembly.
   2. Design and size components to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of wall.
   3. Design Pressure: In accordance with wind loads and exterior wall pressures indicated on structural drawings.
   4. Fire Performance: Tested in accordance with, and complying with acceptance criteria of NFPA 285.
   5. Maximum Allowable Deflection of Panel: L/180 for length(L) of span.
   6. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
   7. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
   8. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.

B. Exterior Wall Panels:
   1. Basis of Design Product: HARRYWOOD by MAC Architectural Metals.
      a. Profile: Horizontal.
      b. Material: Precoated steel sheet, 26 gauge, 0.0217 inch minimum thickness.
      c. Panel Width: 144 inches.
      d. Panel Height 6 inches, nominal.
      e. Panel Depth: 0.34 inches.
      f. Panel Orientation: Horizontal
      g. Color: As indicated on drawings.
   2. Basis of Design Product: METAL BLOCK by MAC Architectural Metals.
      a. Material: Precoated steel sheet, 24 gauge, 0.0276 inch minimum thickness.
      b. Panel Height 12_ inches.
      c. Panel Orientation: As indicated on Drawings.
      d. Color: As indicated on drawings.
   3. Basis of Design Product: MS 380 by MAC Architectural Metals.
      a. Profile: Corrugated profile.
      b. Material: Precoated steel sheet, 26 gauge, 0.0217 inch minimum thickness.
      c. Panel Height 21 inches.
      d. Panel Depth: 3/8 inches.
      e. Panel Orientation: As indicated on Drawings.
      f. Color: As indicated on drawings.

2.03 MATERIALS

A. Precoated Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A653/A653M, Structural Steel (SS) or Forming Steel (FS), with G90/Z275 coating; continuous coil-coated on exposed surfaces with specified finish coating and on panel back with specified panel back coating.

B. Provide accessory materials for a complete metal panel installation as indicated on Drawings.

2.04 FINISHES

A. Fluoropolymer Coil Coating System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of coil coated metal surfaces having minimum total dry film thickness (DFT) of 0.9 mil, 0.0009 inch; color and gloss as selected by Architect from manufacturer’s standard line.

2.05 ACCESSORIES

A. Support for Cladding and Continuous Insulation: Thermal clips.
   1. Thermally-broken clips that provide attachment support for girts, angles, channels, and other cladding support framing.
   2. Fasteners: As recommended by clip manufacturer.

B. Concealed Sealants: Non-curing butyl sealant or tape sealant, see Section 07 92 00

C. Fasteners: Manufacturer's standard type to suit application; stainless steel.

D. Field Touch-up Paint: As recommended by panel manufacturer.

E. Provide accessory materials for a complete installation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that building framing members are ready to receive panels.

B. Verify weather barrier, see Section 07 27 26, has been installed over wall panel substrate; see Section 05 40 00.

3.02 PREPARATION

A. Protect surrounding areas and adjacent surfaces from damage during execution of this work.

3.03 INSTALLATION

A. Install panels on walls and soffits in accordance with manufacturer's instructions.

B. Protect surfaces in contact with cementitious materials and dissimilar metals with bituminous paint; allow to dry prior to wall panel installation.

C. Fasten panels to structural supports; aligned, level, and plumb.

D. Locate joints over supports.

E. Use concealed fasteners unless otherwise indicated by Architect.

F. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.

3.04 TOLERANCES

A. Offset From True Alignment Between Adjacent Members Abutting or In Line: 1/16 inch, maximum.

B. Variation from Plane or Location As Indicated on Drawings: 1/4 inch, maximum.

3.05 CLEANING

A. Remove site cuttings from finish surfaces.

B. Remove protective material from wall panel surfaces.

C. Upon completion of installation, thoroughly clean prefinished aluminum surfaces in accordance with AAMA 609 & 610.

3.06 PROTECTION

A. Protect metal wall panels until completion of project.

B. Touch-up, repair, or replace damaged wall panels or accessories before Date of Substantial Completion.

END OF SECTION

SECTION 07 52 00
MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Work includes all labor, materials, equipment and services necessary for installation of torch-applied SBS modified bituminous membrane roofing system.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. ASCE 7-16, Minimum Design Loads for Buildings and Other Structures.

B. American Society for Testing and Materials (ASTM):
   1. ASTM D41 Standard Specification for Asphalt Primer Used in Roofing, Damp Proofing and Waterproofing.
   2. ASTM D312 Standard Specification for Asphalt Used in Roofing.
   3. ASTM D451 Standard Test Method for Sieve Analysis of Granular Mineral Surfacing for Asphalt Roofing Products.
   4. ASTM D1079 Standard Terminology Relating to Roofing, Waterproofing and Bituminous Materials.
   5. ASTM D1227 Standard Specification for Emulsified Asphalt used as a Protective Coating for Roofing.
   6. ASTM D1863 Standard Specification for Mineral Aggregate used as a Protective Coating for Roofing.
   7. ASTM D2178 Standard Specification for Asphalt Glass Felt used as a Protective Coating for Roofing.
   8. ASTM D2822 Standard Specification for Asphalt Roofing Cement.
   9. ASTM D2824 Standard Specification for Aluminum-pigmented Asphalt Roof Coating.
   10. ASTM D4601 Standard Specification for Asphalt Coated Glass Fiber Base Sheet used in Roofing.
   11. ASTM D5147 Standard Test Method for Sampling and Testing Modified Bituminous Sheet Materials.
   12. ASTM D6162 Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials using a combination of Polyester and Glass Fiber Reinforcements.
   13. ASTM D6163 Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials using Glass Fiber Reinforcements.
   14. ASTM E108 Standard Test Methods for Fire Test of Roof Coverings.

C. Factory Mutual Research (FM):
   1. Roof Assembly Classifications.
   2. ANSI/SPRI/Fm 4435/ES-1 Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems.

D. National Roofing Contractors Association (NRCA):
   1. Roofing and Waterproofing Manual.

E. Underwriters Laboratories, Inc. (UL):
   1. Fire Hazard Classifications.

F. Warnock Hersey (WH):
   1. Fire Hazard Classifications.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meeting: Conduct at Project Site.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including set up and mobilization areas for stored material and work area.
3. Review safety procedures and site-specific requirements relating to the work and areas to be accessed.
4. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
5. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
6. Review structural loading limitations of roof deck during and after roofing.
7. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
8. Review governing regulations and requirements for insurance and certificates if applicable.
9. Review temporary protection requirements for roofing system during and after installation.
10. Review roof observation and repair procedures after roofing installation.
11. Review notification procedures for weather or non-working days.
12. Review compatibility of copings and roof-edge metal with the roofing system warranty, including products the roofing system manufacturer requires as a condition of that warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with not less than 15 years documented experience and have ISO 9001 certification.

B. Installer Qualifications: Company specializing in modified bituminous roofing installation with not less than 5 years experience and authorized by roofing system manufacturer as qualified to install manufacturer's roofing materials.

C. Installer's Field Supervision: Maintain a full-time Supervisor/Foreman on job site during all phases of roofing work while roofing work is in progress. Supervisor/Foremen must be fluent in the English language and maintain proper supervision of workmen.

D. Maintain a copy of the Contract Documents in the possession of the Supervisor/Foreman and on the roof at all times.

E. Source Limitations: Obtain all components of roof system from a single manufacturer. Secondary products that are required shall be recommended and approved in writing by the roofing system Manufacturer.
   1. Upon request of the Architect or Owner, submit Manufacturer's written approval of secondary components in list form, signed by an authorized agent of the Manufacturer.
   2. Manufacturer shall have direct authority and control over all fabrication of steel components as well as the raw materials used in their fabrication.

F. Source Quality Control: Manufacturer shall have in place a documented, standardized quality control program such as ISO 9001 approval.

G. Engage the Manufacturer's Field Representative to conduct required periodic inspections of work in progress as described herein and shall furnish written documentation of all such inspections.

H. Manufacturer shall provide the project Owner with a written statement that they will provide site inspections three days per week that confirms that the project is being constructed as specified, by an experienced, full time employee of the company.

I. Roof Edge Metal and Copings: Obtain copings, fascia, and other roof-edge metal, including those specified in Section 07 62 00, approved in writing by the roofing system manufacturer and complying with the roofing system manufacturer's requirements for the specified warranty. Where the roofing system manufacturer produces copings or roof-edge metal, provide that manufacturer's products.
   1. Copings and roof-edge metal shall be tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the design pressures indicated on the Drawings.

1.05 SUBMITTALS

A. Manufacturer's Installation Instructions: Submit installation instructions and recommendations indicating special precautions required for installing the membrane.

B. Manufacturer's Certificate: Certify that roof system furnished is approved by Factory Mutual, Underwriters Laboratories, Warnock Hersey or approved third party testing facility in accordance with ASTM E108, Class A for external fire and meets local or nationally recognized building codes.

C. Manufacturer's Certificate: Certify that the roof system furnished is approved or accepted by Factory Mutual Approval Standard 4470.

D. Manufacturer's Certificate: Certify that materials are manufactured in the United States and conform to requirements specified herein, are chemically and physically compatible with each other, and are suitable for inclusion within the total roof system specified herein.

E. Manufacturer's Certificate: Submit a certified copy of the roofing manufacturer's ISO 9001 compliance certificate.

F. Test Reports: Submit test reports, prepared by an independent testing agency, for all modified bituminous sheet roofing, indicating compliance with ASTM D5147.

G. Written certification from the roofing system manufacturer certifying the applicator is currently authorized for the installation of the specified roof system.

H. Design Loads: Submit copy of manufacturer's minimum design load calculations according to ASCE 7-16, Method 2 for Components and Cladding, sealed by a registered professional engineer. In no case shall the design loads be taken to be less than those detailed in Design and Performance Criteria article of this specification.

I. Specimen Warranty: Provide an unexecuted copy of the warranty specified for this Project, identifying the terms and conditions required of the Manufacturer and the Owner.

J. Warranty Compatibility Certification: Letter from the roofing system manufacturer identifying by manufacturer and product name the copings and roof-edge metal proposed for the Project, and confirming that those products are included in the roofing system warranty at the term and coverage specified. Submit before fabrication of copings and roof-edge metal.

1.06 CLOSEOUT SUBMITTALS

A. Special Project Warranty: Provide specified warranty for the Project, executed by the authorized agent of the Manufacturer.

B. Roofing Maintenance Instructions: Provide a manual of manufacturer's recommendations for maintenance of installed roofing systems.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.08 WARRANTY

A. Upon completion of installation, and acceptance by the Owner and Architect, the Manufacturer will supply to the Owner Manufacturer's Watertight Warranty, without monetary limitations in which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Thirty (30) years from date of Substantial Completion.

B. Installer’s Warranty: Provide roofing installers warranty, to the membrane manufacturer, in which the roofing installer will, at his own expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.
   1. Warranty Period: Five (5) years from date of Substantial Completion.

C. The Roof System Manufacturer shall provide annual inspection of the roof for the duration of the warranty at no fee to the Owner.

D. Roof Edge Metal and Copings: Copings and roof-edge metal are included in the roofing system warranty. Where the roofing system manufacturer requires its own copings or roof-edge metal as a condition of the specified warranty term and coverage, provide that manufacturer’s products.
   1. Products that reduce the term or coverage of the roofing system warranty are not permitted.

E. Roofing system manufacturer to be affiliated with the air-barrier manufacturer specified in Section 07 27 26, to provide unified building-envelope warranty coverage.

1.09 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

B. Do not apply roofing insulation or membrane to damp deck surface.

C. Do not expose materials subject to water or solar damage in quantities greater than can be weatherproofed during same day.

D. Phased Construction will not be accepted.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Manufacturer: The Garland Company, Inc.
   1. 3800 East 91st Street, Cleveland, OH, 44105
   2. Manufacturer’s Representative:
      a. James Roberts; jroberts@garlandco.com; 832-525-8079

B. Modified bituminous roofing shall include but not be limited to:
   1. Base Ply Sheet Modified Membrane: Type III membrane complying with ASTM 6163, Grade S. Physical requirements below.
   2. Cap Ply Sheet Modified Membrane: Type III membrane complying with ASTM 6162, Grade G. Physical requirements below.

3. Stripping Ply Sheet Modified Membrane: Type III membrane complying with ASTM 6163, Grade S. Physical requirements below.
4. Base Flashing Assembly: Two ply modified, heat fused with the finished ply meeting Type III membrane complying with ASTM 6162, Grade G minimum requirements and base ply meeting Type III membrane complying with ASTM 6163, Grade S minimum.

C. Basis of Design Materials, manufacturer's product designations, and/or manufacturer's names specified herein shall be regarded as the minimum standard of quality required for work of this Section. Comply with all manufacturer and contractor/fabricator quality and performance criteria specified in Part 1.

2.02 PERFORMANCE CRITERIA

A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.

B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

C. Solar Reflectance Index: Not less than 70 when calculated according to ASTM E1980, based on testing identical products by a qualified testing agency.

D. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.03 ROOFING SHEET MATERIALS

A. Base Ply Sheet Modified Membrane: ASTM D 6163, Grade S, Type III, 120 mil SBS-modified asphalt sheet; suitable for application method specified, and as follows: HPR Torchbase.
1. Tensile Strength, ASTM D 5147:
   a. 2 inch/min. @ 73.4 +/- 3.6 deg. F MD 210 lbf/in XD 210 lbf/in
   b. 1.97 inch/min. @ 23 +/- 2 deg. C MD 36.75 kN/m XD 36.75 kN/m
2. Tear Strength, ASTM D 5147:
   a. 2 inch/min. @ 73.4 +/- 3.6 deg. F MD 300 lbf XD 300 lbf
   b. 1.97 inch/min. @ 23 +/- 2 deg. C MD 1334 N XD 1334 N
3. Elongation at Maximum Tensile, ASTM D 5147:
   a. 2 inch/min. @ 73.4 +/- 3.6 deg. F MD 6.0% XD 6.0%
   b. 1.97 inch/min. @ 23 +/- 2 deg. C MD 6.0% XD 6.0%
4. Low Temperature Flexibility, ASTM D5147, Passes -30 deg. F (-34 deg. C)

B. Granule-Surfaced Roofing Cap Sheet: ASTM D 6162, Grade G, Type III, 195 mil SBS-modified asphalt sheet with fiberglass and polyester composite scrim; suitable for application method specified, and as follows: Stressply IV Plus UV Mineral.
1. Tensile Strength, ASTM D 5147:
   a. 2 inch/min. @ 73.4 +/- 3.6 deg. F MD 310 lbf/in XD 310 lbf/in
   b. 1.97 inch/min. @ 23 +/- 2 deg. C MD 54.25 kN/m XD 54.25 kN/m
2. Tear Strength, ASTM D 5147:
   a. 2 inch/min. @ 73.4 +/- 3.6 deg. F MD 510 lbf XD 510 lbf
   b. 1.97 inch/min. @ 23 +/- 2 deg. C MD 2269 N XD 2269 N
3. Elongation at Maximum Tensile, ASTM D 5147:
   a. 2 inch/min. @ 73.4 +/- 3.6 deg. F MD 6% XD 6%
   b. 1.97 inch/min. @ 23 +/- 2 deg. C MD 6% XD 6%
4. Low Temperature Flexibility, ASTM D 5147, Passes -40 deg. F (-40 deg. C)

2.04 BASE FLASHING SHEET MATERIALS

A. Base Ply Sheet Modified Membrane: ASTM D 6163, Grade S, Type III, 120 mil SBS-modified asphalt sheet; suitable for application method specified, and as follows: HPR Torchbase.
   1. Tensile Strength, ASTM D 5147:
      a. 2 inch/min. @ 73.4 +/- 3.6 deg. F MD 210 lbf/in XD 210 lbf/in
      b. 1.97 inch/min. @ 23 +/- 2 deg. C MD 36.75 kN/m XD 36.75 kN/m
   2. Tear Strength, ASTM D 5147:
      a. 2 inch/min. @ 73.4 +/- 3.6 deg. F MD 300 lbf XD 300 lbf
      b. 1.97 inch/min. @ 23 +/- 2 deg. C MD 13342N XD 1334N
   3. Elongation at Maximum Tensile, ASTM D 5147:
      a. 2 inch/min. @ 73.4 +/- 3.6 deg. F MD 6.0% XD 6.0%
      b. 1.97 inch/min. @ 23 +/- 2 deg. C MD 6.0% XD 6.0%
   4. Low Temperature Flexibility, ASTM D5147, Passes -30 deg. F (-34 deg. C)

B. Granule-Surfaced Roofing Cap Sheet: ASTM D 6162, Grade G, Type III, 195 mil SBS-modified asphalt sheet with fiberglass and polyester composite scrim; suitable for application method specified, and as follows: Stressply IV Plus UV Mineral.
   1. Tensile Strength, ASTM D 5147:
      a. 2 inch/min. @ 73.4 +/- 3.6 deg. F MD 310 lbf/in XD 310 lbf/in
      b. 1.97 inch/min. @ 23 +/- 2 deg. C MD 54.25 kN/m XD 54.25 kN/m
   2. Tear Strength, ASTM D 5147:
      a. 2 inch/min. @ 73.4 +/- 3.6 deg. F MD 510 lbf XD 510 lbf
      b. 1.97 inch/min. @ 23 +/- 2 deg. C MD 2269 N XD 2269 N
   3. Elongation at Maximum Tensile, ASTM D 5147:
      a. 2 inch/min. @ 73.4 +/- 3.6 deg. F MD 6% XD 6%
      b. 1.97 inch/min. @ 23 +/- 2 deg. C MD 6% XD 6%
   4. Low Temperature Flexibility, ASTM D 5147, Passes -40 deg. F (-40 deg. C)

2.05 BITUMINOUS ROOFING MATERIALS

A. General: Auxiliary materials provided or recommended by roofing system manufacturer for intended use and compatible with roofing.

B. Liquid Flashing - Tuff-Flash: An asphaltic-polyurethane, low odor, liquid flashing material designed for specialized details unable to be waterproofed with typical modified membrane flashings.

C. Asphalt Primer: ASTM D41/D41M. Garla-Prime.

D. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing system manufacturer for application. Flashing-Bond.

E. Mastic Sealant: Polyisobutylene, plain or modified bitumen; non-hardening, non-migrating, non-skinning, and non-drying. Garla-Flex.

F. Flashing Mastic: ASTM D4586, asbestos free, trowel grade, of consistency required by roofing system manufacturer for three-course application of base flashings. Silver Flash.

G. Miscellaneous Materials: Provide those recommended by roofing system manufacturer.

2.06 ROOF BOARD INSULATION

A. Base Layer Insulation: Rigid, closed cell polyisocyanurate rigid board insulation utilizing non-chlorine/non-ozone depleting blowing agent, bonded to non-asphaltic organic fiberglass facers, ASTM C1289, Type II, Class 1, Grade 2 20 psi. Minimum thickness 4.5-inch, installed in two separate layers: “WPG-Flat” by Wise Products Group or pre-approved equal.

B. Tapered Insulation: Rigid, closed cell polyisocyanurate rigid board insulation utilizing non-chlorine/non-ozone depleting blowing agent, bonded to non-asphaltic organic fiberglass facers,

ASTM C1289, Type II, Class 1, Grade 2 20 psi, tapered 1/4” per foot: “WPG-Tapered” by Wise Products Group or pre-approved equal.

C. Secondary Insulation Layer/Cover Board: Moisture resistant, 1/2-inch thick gypsum roof board, ASTM C 1278; provide 48” by 48” nominal size: “DensDeck Prime” by Georgia Pacific or pre-approved equal.

D. Tapered Edge Strip: Tapered perlite complying with ASTM C728.

E. Low-rise Foam Insulation Adhesive: Dual-component, VOC compliant, two-part reaction-cure urethane foam adhesive: “Insul-Lock HR” by The Garland Co., Inc

2.07 SURFACING

A. Roofing Granules: Ceramic-coated roofing granules as provided by the prime material manufacturer, No. 11 screen size with 100 percent passing No. 8 (2.36-mm) sieve and 98 percent of mass retained on No. 40 (0.425-mm) sieve, color to match roofing.

2.08 RELATED MATERIALS

A. Plumbing stacks should be 4lb (1.8kg) sheet lead formed and rolled.

B. Nails and Fasteners: Non-ferrous metal or galvanized steel, except that hard copper nails shall be used with copper; aluminum or stainless steel nails shall be used with aluminum; and stainless steel nails shall be used with stainless steel. Fasteners shall be self-clinching type of penetrating type as recommended by the manufacturer of the deck material. Nails and fasteners shall be flush-driven through flat metal discs of not less than one (1) inch diameter. Omit metal discs when one-piece composite nails or fasteners with heads not less than one (1) inch diameter are used.

C. Butyl Tape: 100% solids, asbestos free and compressive tape designed to seal as recommended and furnished by the membrane manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that deck surfaces and project conditions are ready to receive work of this Section.

B. Verify that deck is supported and secured to structural members.

C. Verify that deck is clean and smooth, free of depressions, projections or ripples, and is properly sloped.

D. Verify that adjacent roof substrate components do not vary more than ¼ inch in height.

E. Verify that deck surfaces are dry.

F. Verify that openings, curbs, pipes, conduit, sleeves, ducts, and other items which penetrate the roof are set solidly, and that cant strips, wood nailing strips, and reglets are set in place.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Cooperate with manufacturer, inspection and test agencies engaged or required to perform services in connection with installing the roof system.

B. Insurance/Code Compliance: Where required by code, install and test the roofing system to comply with governing regulation and specified insurance requirements.

C. Protect other work from spillage of roofing materials and prevent materials from entering or clogging drains and conductors. Replace or restore other work damaged by installation of the modified bituminous roofing system.

D. Coordinate installation of roofing system so insulation and other components of the roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

1. Provide tie-offs at end of each day's work to cover exposed roofing sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt, with joints and edges sealed.
2. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

E. Substrate Joint Penetrations: Prevent bitumen from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

F. Apply roofing materials as specified by manufacturer's instructions:
1. Keep roofing materials dry before and during application.
2. Do not permit phased construction.
3. Complete application of roofing plies, modified sheet and flashing in a continuous operation.
4. Begin and apply only as much roofing in one day as can be completed that same day.

G. Cut-Offs (Waterstops): At end of each day's roofing installation, protect exposed edge of incomplete work, including ply sheets and insulation.

H. Broadcast minerals into the bleed out of bitumen while bitumen is at its recommended EVT temperature to achieve a monolithic appearance.

3.03 ROOF BOARD INSULATION INSTALLATION

A. General:
1. Install insulation to achieve positive drainage across the roof deck in general accordance with manufacturer’s guidelines.
2. Stagger end joints of insulation boards ½ of overall length of board.
3. Butt joints tightly allowing no more than ¼-inch wide gaps between units. Fill joints between adjacent boards with like insulation or foam adhesive.
4. Do not use warped, bent or otherwise damaged insulation boards.
5. Field cut and fit insulation at penetrations, curbs, and walls.
6. Stagger all joints (side and end) between layers of insulation.
7. Field cut tapered insulation boards to create crickets at upslope sides of curbs and along walls to achieve a minimum resulting roof slope of ¼” per foot.
8. Install tapered edge strips at changes in elevations, edge of crickets and other locations to create a monolithic and uniform substrate for installation of roofing membrane.

B. Adhered Layers of Insulation:
1. Adhere tapered insulation layer and cover board to base insulation layer.
2. Stagger end joints of insulation boards ½ of overall length of board. Stagger joints of subsequent insulation layers from underlying insulation layer.
3. Butt joints of insulation layers tightly allowing no more than ¼-inch wide gaps between units. Fill joints or gaps greater than 1/8-inch between adjacent boards with low-rise foam adhesive.
4. Do not use warped, bent, or otherwise damaged insulation boards. Discard damaged boards.
5. Field cut and fit insulation boards at penetrations, curbs, and walls. Field cut tapered insulation boards to create crickets at upslope sides of curbs and along walls.
6. Install cover board over insulation in accordance with manufacturer’s guidelines.

C. Ribbon Application (Urethane Foam Insulation Adhesive):
1. Dispense 1/2-inch wide continuous ribbons of adhesive on substrate to adhere insulation board.
2. Place the initial ribbon of adhesive 3-inches inside each edge/side of the insulation board in a picture-frame fashion. Apply additional parallel ribbons of adhesive across the

remainder of the board in a serpentine fashion and spaced according to roof membrane manufacturer's ASCE 7-10 calculations.

3. Firmly set insulation boards in the ribbons of foam adhesive following application of the adhesive when adhesive has risen to proper height and walk-in the insulation to spread the adhesive ribbons, ensuring maximum contact. Do not push or slide insulation into position. Set weighted objects on ends, sides, and corners of boards until adhesive has set and insulation is firmly attached.
4. On additional insulation layers, dispense ribbons of adhesive in direction perpendicular to the direction of the beads that were dispensed on the underlying layer.
5. Fill voids or open joints in top layer of insulation with spray-foam adhesive to provide monolithic surface to receive new membrane.
6. Adhere partial boards and tapered edge strips with adhesive ribbon positioned in picture-frame fashion along perimeter of board and remaining adhesive ribbons spaced in accordance with location on roof (field, perimeter, corner).
7. At end of each work day, provide staggered ends of installed boards so that proper joint stagger can be achieved on following roof installation

3.04 SBS MODIFIED BITUMINOUS BASE PLY MEMBRANE INSTALLATION

A. Install base ply according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants, installing as follows:
   1. Lay out the roll in the course to be followed and unroll 6 feet.
   2. Using a roofing torch, heat the surface of the coiled portion until the burn-off backer melts away. At this point, the material is hot enough to lay into the substrate. Progressively unroll the sheet while heating and insure a proper bond.
   3. After the major portion of the roll is bonded, re-roll the first 6 feet and bond it in a similar fashion.
   4. Repeat this operation with subsequent rolls with side laps of 4 inches and end laps of 8 inches.
   5. Give each lap a finishing touch by passing the torch along the joint and spreading the melted bitumen evenly with a rounded trowel to insure a smooth, tight seal.
   6. Extend underlayment 2 inches beyond top edges of cants at wall and projection bases.
   7. Install base flashing ply to all perimeter and projections details.

B. Laps: Accurately align roofing sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.
   1. Repair voids in laps and lapped seams not completely sealed.

C. Install roofing sheets so side and end laps shed water.

3.05 SBS MODIFIED BITUMINOUS CAP SHEET MEMBRANE INSTALLATION

A. Install modified bituminous cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants, installing as follows:
   1. Lay out the roll in the course to be followed and unroll 6 feet.
   2. Using a roofing torch, heat the surface of the coiled portion until the burn-off backer melts away. At this point, the material is hot enough to lay into the substrate. Progressively unroll the sheet while heating and insure a proper bond.
   3. After the major portion of the roll is bonded, re-roll the first 6 feet and bond it in a similar fashion.
   4. Repeat this operation with subsequent rolls with side laps of 4 inches and end laps of 8 inches.
   5. Give each lap a finishing touch by passing the torch along the joint and spreading the melted bitumen evenly with a rounded trowel to insure a smooth, tight seal.

6. Immediately broadcast new granules into bleedout while hot bitumen is still at EVT. All loose granules to be removed at end of project.

3.06 BASE FLASHING AND STRIPPING INSTALLATION

A. Install base flashing over cant strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to roofing system manufacturer's written instructions. Minimum base-flashing height of 8 inches is required. Install modified bituminous roofing sheet and cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants, installing as follows:
   1. Seal all curb, wall and parapet flashings with an application of mastic and mesh on a daily basis. Do not permit conditions to exist that will allow moisture to enter behind, around or under the roof or flashing membrane.
   2. Prepare all walls, penetrations, expansion joints and where shown on the drawings to be flashed with asphalt primer at the rate of one hundred (100) square feet per gallon. Allow primer to dry tack free.
   3. Heat fuse entire base ply membrane until burn off paper is gone. Fully adhere membrane to the underlying substrate.
   4. After the laps have been tested and complete positive bond has been achieved, the applicator shall heat the seam edge and trowel along the seam edge. Troweling shall continue until a sloped, beveled edge has been produced.
   5. Heat fuse finished membrane in the same manner as base ply. Seal all vertical laps of flashing membrane with a three-course application of trowel-grade mastic and fiberglass mesh. Install termination bar at top of assembly and seal with a three-course application of trowel-grade mastic and fiberglass mesh.
   6. Terminate all base flashings using extruded aluminum termination bar. Three-course all terminations with fiberglass mesh and specified mastic.

B. Install roofing cap-sheet stripping where metal flanges and edgings are set on roofing according to roofing system manufacturer's written instructions.

3.07 REFLECTIVE BASE FLASHING COATING APPLICATION

A. Base Flashing roofing plies and mastics shall be allowed to cure for thirty (30) days prior to application of the coating system.

B. Prior to coating application, all loose, non-embedded granule surfacing material is to be removed from the base flashings by means of a stiff bristle street broom, powered mechanical sweeper, or vacuuming. All loose dirt and dust remaining after granule removal is to be broomed or vacuumed from the base flashing surface. All blisters, ridges and other imperfections must be secured so that the surface will be clean and dry and a secure base for coating application.
   1. The first coat of the Base Coat shall be applied the same day as the surface is cleaned. In no case shall the coating be applied over a dirty surface.
   2. The coating system shall be roller applied in a cross hatch technique without causing runs or puddles.
   3. The coating system shall be evenly applied in at least 2 separate coats to achieve a minimum system of 22-32 mils dry film thickness. Allow thorough dry time between coats.
   4. No coating shall be applied if weather will not allow it to dry prior to exposure to precipitation or freezing temperatures.

3.08 ROOF DETAIL INSTALLATION

A. Coordinate counter flashing, cap flashings, expansion joints, and similar work with modified bitumen roofing work (as specified in other Sections).

B. Coordinate roof accessories, miscellaneous sheet metal accessory items, including piping vents and other devices with the roofing system work (as specified in other Sections).

C. Curb Detail:
   1. Minimum curb height is eight (8) inches. Prime vertically at a rate of one hundred (100) square feet per gallon and allow to dry.
   2. Set cant in bitumen. Run all field plies over cant a minimum of two (2) inches.
   3. Install base flashing assembly.
   4. Install pre-manufactured counter-flashing with fasteners and neoprene washers or per manufacturer's recommendations.

D. Flanged Penetration Detail:
   1. Minimum stack height is twelve (12) inches.
   2. Run roof system over the entire surface of the roof. Seal the base of the stack with elastomeric sealant.
   3. Prime both surfaces of flange of new sleeve. Install properly sized sleeves set in (¼) inch bed of roof cement.
   4. Install stripping ply prior to cap sheet installation.

3.09 FIELD QUALITY CONTROL

A. Perform manufacturer’s field inspection and as required a minimum of three (3) days per week.

B. Correct defects or irregularities discovered during field inspection.

C. Roofing materials manufacturer's must be present at the site during installation of the roofing system.

D. Manufacturer Services
   1. Manufacturer’s Field Representative: An authorized, full-time employee of the roof system manufacturer shall be assigned to the project to conduct field observations during the installation phase.
   2. Regularly scheduled site observations shall be required by the manufacturer’s field representative a minimum of three (3) days per week during the roofing installation period; exceptions being made for inclement weather, holidays, etc.
   3. Observation reports shall include the following:
      a. Written report/documentation of the installation progress at the time of the site visit to be delivered to the architect and owner within 48 hours of the site visit.
      b. This report shall include documentation of any issues/question and resolution.
      c. This report shall include record of directives given to the roofing contractor.
      d. Digital photographic documentation of the roofing progress; including documentation of specific issues and areas of concern.
      e. Each report shall contain project name, architect’s project number, and date/time/duration of site visit.
   4. In addition to the progress observations, the manufacturer’s representative must:
      a. Attend the roofing trade start-up meeting.
      b. Inspect and approve the roof substrate/deck prior to the start of roofing work.
   5. All observation reports shall be kept current and shall be delivered electronically to the architect and contractor within five (5) calendar days after the observation. Progress payments for roofing work may be withheld if observation report submissions are not current.
   6. After completion of all roofing work, and prior to acceptance of the roofing installation, the manufacturer’s representative shall conduct an observation to document all roofing work to be corrected as a condition of acceptance.
      a. Each item requiring corrective work shall be identified (including specific location) and required corrective action shall be noted.
      b. The final observation report must be produced in writing with photographic back-up. Marking corrective items on the roof alone shall not be acceptable.
   7. Any failure by the Architect, the Owner’s Representative, the Project Manager, or the roofing manufacturer’s Technical Field Representative to observe, detect, pinpoint, or

object to any defect or noncompliance with the requirements of the Roofing Manufacturer's requirements, the Contract Documents, the Project Specifications, the approved Shop Drawings and Engineering Data, and/or the Roofing Manufacturer's standard details – of work in progress or completed work – shall not relieve the Contractor of, or reduce, or in any way limit, his responsibility of full performance of the work required of him under the requirements of the Roofing Manufacturer, the Contract Documents, the Project Specifications, the approved Shop Drawings and Engineering Data, and/or the Roofing Manufacturer's standard details.

E. Final Inspection
   1. At completion of roofing installation and associated work, meet with Contractor, Architect, installer, installer of associated work, Owner, roofing system manufacturer's representative, and other representatives directly concerned with performance of roofing system.
   2. Walk roof surface areas of the building, inspect perimeter building edges as well as flashing of roof penetrations, walls, curbs and other equipment. List all items requiring correction or completion and furnish copy of list to each party in attendance.
   3. The roofing system manufacturer reserves the right to request a thermographic scan of the roof during final inspection to determine if any damp or wet materials have been installed. The thermographic scan shall be provided by the Roofing Contractor.
   4. If core cuts verify the presence of damp or wet materials, the Roofing Contractor shall be required to replace the damaged areas at his own expense.
   5. Repair or replace deteriorated or defective work found at time above inspection as required to a produce an installation which is free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
   6. Notify the Owner and Architect upon completion of corrections.
   7. Following the final inspection, provide written notice of acceptance of the installation from the roofing system manufacturer.
   8. Immediately correct roof leakage during construction. If the Contractor does not respond within twenty four (24) hours, the Owner will exercise rights to correct the Work under the terms of the Conditions of the Contract.

3.10 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Remove bitumen adhesive drippings from all walls, windows, floors, ladders and finished surfaces.

D. In areas where finished surfaces are soiled by asphalt or any other sources of soiling caused by work of this Section, consult manufacturer of surfaces for cleaning instructions and conform to their instructions.

E. Repair or replace defaced or disfigured finishes caused by work of this Section.

F. Remove and properly dispose of waste products generated during roofing procedures. Comply with requirements of authorities having jurisdiction.

END OF SECTION

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fabricated sheet metal items, including flashings, counterflashings, exterior penetrations, copings, and other items indicated in Schedule.

B. Sealants for joints within sheet metal fabrications.

C. Precast concrete splash pads.

1.02 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

B. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

C. ASTM B32 - Standard Specification for Solder Metal.

D. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction.

E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

F. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement.

G. SMACNA (ASMM) - Architectural Sheet Metal Manual.

1.03 SUBMITTALS

A. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA (ASMM) requirements and standard details, except as otherwise indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

B. Prevent contact with materials that could cause discoloration or staining.

1.06 WARRANTIES

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 20 years from date of substantial completion.

PART 2 PRODUCTS

2.01 SHEET MATERIALS

A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch thick base metal.

B. Stainless Steel: ASTM A666/A666M, Type 304 alloy, soft temper, 28 gauge, 0.0156 inch thick; smooth No. 4 - Brushed finish.

C. Copper: ASTM B370, cold rolled 16 oz/sq ft, 24 gauge, 0.0216 inch thick; natural finish.

2.02 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.

B. Fabricate cleats of same material as sheet, minimum 3 inches wide, interlocking with sheet.

C. Form pieces in longest possible lengths.

D. Hem exposed edges on underside 1/2 inch; miter and seam corners.

E. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.

F. Fabricate corners from one piece with minimum 18-inch long legs; seam for rigidity, seal with sealant.

2.03 FLASHING

A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

2.04 ACCESSORIES

A. Fasteners: Galvanized steel, with soft neoprene washers.

B. Underlayment: Polyethylene, 6 mil, 0.006 inch thick.

C. Primer Type: Zinc chromate.

D. Concealed Sealants: Non-curing butyl sealant.

E. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.

F. Fenestration Perimeter Flashing Attachments: Two-piece flashing receiver and clip of extruded aluminum, at least 0.045 inch thick, for attaching flashing at perimeter of exterior wall fenestration openings.
   1. Provide flashing receiver profile appropriate for flashing applications.

G. Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.

H. Reglets: Surface-mounted type, galvanized steel; face and ends covered with plastic tape.

I. Solder: ASTM B32, Alloy Grade - Sn50 (50/50).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

B. Verify roofing termination and base flashings are in place, sealed, and secure.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage and securely anchored.

D. Verify that air-barriers have been installed over substrate to prevent air infiltration or water penetration

3.02 PREPARATION

A. Install surface mounted reglets true to lines and levels, and seal top of reglets with sealant.

B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch.

3.03 INSTALLATION

A. Insert flashings into reglets to form tight fit; secure in place with lead wedges; pack remaining spaces with lead wool; seal flashings into reglets with sealant.

B. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted.

C. Apply plastic cement compound between metal flashings and felt flashings.

D. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.

E. Exterior Flashing Receivers: Install in accordance with manufacturer's recommendations, and in proper relationship with adjacent construction, and as follows:
   1. Secure receiver at perimeter of wall opening with adhesives or fasteners.
   2. Place flashing into receiver channel.
   3. Secure flashing with receiver clip.

F. Seal metal joints watertight.

G. Where dissimilar metals contact each other, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer.

H. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

3.04 FIELD QUALITY CONTROL

A. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

END OF SECTION

SECTION 07 72 00
ROOF ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof hatches.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used.
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
   4. Maintenance requirements.

B. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store products under cover and elevated above grade.

PART 2 PRODUCTS

2.01 ROOF HATCHES AND VENTS

A. Roof Hatch Manufacturers:
   1. Babcock-Davis: www.babcockdavis.com/#sle.
   2. Basis of Design - Bilco Company; Type E (ladder access, 3 ft square, solid cover): www.bilco.com/#sle.
   3. Nystrom, Inc: www.nystrom.com/#sle.

B. Frames and Curbs: One-piece curb and frame with integral cap flashing to receive roof flashings; extended bottom flange to suit mounting.
   1. Material: Mill finished aluminum, 11 gauge, 0.0907 inch thick.
   2. Insulation: Manufacturer's standard; 1 inch rigid wood fiber board, located on outside face of curb.
   3. Curb Height: 12 inches from finished surface of roof, minimum.

C. Metal Covers: Flush, insulated, hollow metal construction.
   1. Capable of supporting 40 psf live load.
   2. Material: Mill finished aluminum; outer cover 11 gauge, 0.0907 inch thick, liner 0.04 inch thick.
   3. Insulation: Manufacturer's standard 1 inch rigid glass fiber.
   4. Gasket: EPDM, continuous around cover perimeter.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using methods recommended by manufacturer for achieving acceptable results for applicable substrate under project conditions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions, in manner that maintains roofing system weather-tight integrity.

3.04 CLEANING

A. Clean installed work to like-new condition.

3.05 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

SECTION 07 84 00
FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Firestopping systems.

B. Firestopping of joints and penetrations in fire-resistance-rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.

C. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

D. ASTM E2174 - Standard Practice for On-Site Inspection of Installed Firestop Systems.

E. ASTM E2393 - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.

F. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-Story Test Apparatus.

G. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed between Rated Wall Assemblies and Nonrated Horizontal Assemblies.

H. ITS (DIR) - Directory of Listed Products.

I. FM 4991 - Approval Standard of Firestop Contractors.

J. FM (AG) - FM Approval Guide.

K. UL 1479 - UL Standard for Safety Fire Tests of Through-Penetration Firestops.

L. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems.

M. UL (DIR) - Online Certifications Directory.

N. UL (FRD) - Fire Resistance Directory.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. On-Site Training: A manufacturer's direct representative (not distributor or agent) to conduct on-site instruction of firestop systems to train appropriate contractor personnel in proper selection and installation procedures and assist Contractor in preparing on-site mock-up.

1.04 SUBMITTALS

A. Furnish a single submittal package, coordinated and complete, covering Work of all trades and all conditions requiring firestopping. Multiple submittals are not acceptable.

B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.

C. Product Data: Provide data on product characteristics, performance ratings, and limitations.

D. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Certificate from authority having jurisdiction indicating approval of materials used.

G. Manufacturer's qualification statement.

H. Installer's qualification statement.

I. Field Quality Control Submittals: Indicate results of installation inspection.

1.05 QUALITY ASSURANCE

A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
   1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.
   2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
   3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.

B. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
   1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
   2. For floor penetrations with annular spaces exceeding 4 inch in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
   3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

C. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

D. Curtainwall fire containment insulation at exterior curtainwall assemblies in compliance with UL Time-Design rating.

E. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

F. Installer Qualifications: Company specializing in performing the work of this section and:
   1. Recognized as a Qualified Contractor in compliance with requirements of UL (DIR) Solutions Qualified Firestop Contractor Program.
   2. Approved by Factory Mutual Research Corporation under FM 4991, or meeting any two of the following requirements:
   3. Verification of minimum three years documented experience installing work of this type.
   4. Verification of at least five satisfactorily completed projects of comparable size and type.
   5. Licensed by local authorities having jurisdiction (AHJ).

G. Source Limitations: Install through-penetration firestop systems throughout the project by a single installer. Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, through one source from a single manufacturer.

1.06 FIELD CONDITIONS

A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.

B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Firestopping Manufacturers:
   1. 3M Fire Protection Products: www.3m.com/firestop.

2. A/D Fire Protection Systems Inc: www.adfire.com.
3. Hilti, Inc: www.us.hilti.com/#sle.
4. Nelson FireStop Products: www.nelsonfirestop.com.
5. Specified Technologies Inc: www.stifirestop.com/#sle.
6. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.

2.02 MATERIALS

A. Firestopping Materials: Any materials meeting requirements.

B. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.

C. Safing Clips: Z-shaped galvanized steel clips formed from 1 inch wide strips of 20 gauge galvanized steel. 3 inches high with 2 inch and 3 inch upper and lower horizontal legs.

D. Backer Bar Assembly: Galvanized sheet steel channels, angles and fasteners in sizes and gauges as required by UL Time-Design assembly rating.

E. Curtain Wall Insulation Hanger System: Sheet steel hangers and accessory hardware for attaching curtain wall insulation.
   1. Product: Impasse System manufactured by Thermafiber: www.thermafiber.com.

F. Backer / Reinforcement Member: Light gauge steel channel or angle approved by primary manufacturer. Place horizontally at the safe-off line to support the curtain wall insulation to prevent bowing of curtain wall insulation caused by compression fitting of the Safing insulation.
   1. Product: Impasse T-Bar manufactured by Thermafiber: www.thermafiber.com.

G. Fire Ratings: Refer to drawings for required systems and ratings.

2.03 FIRESTOPPING ASSEMBLY REQUIREMENTS

A. Perimeter Fire Containment Firestopping: Use system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of floor assembly.
   1. Movement: Provide systems that have been tested to show movement capability as indicated.
   2. Temperature Rise: Provide systems that have been tested to show T Rating as indicated.
   3. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
   4. Where floor assembly is not required to have a fire rating, provide systems that have been tested to show L Rating as indicated.

B. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
   1. Movement: Provide systems that have been tested to show movement capability as indicated.

C. Floor-to-Floor (FF), Floor-to-Wall (FW), Head-of-Wall (HW), and Wall-to-Wall (WW) Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
   1. Movement: Provide systems that have been tested to show movement capability as indicated.
   2. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
   3. Watertightness: Provide systems that have been tested to show W Rating as indicated.
   4. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

D. Membrane Penetration Firestopping: Use system that has been tested according to ASTM E814 or UL 1479 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

1. Temperature Rise: Provide systems that have been tested to show T Rating as indicated.
2. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
3. Watertightness: Provide systems that have been tested to show W Rating as indicated, with a minimum positive pressure differential of 0.01 inch od water.
4. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

E. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
1. Temperature Rise: Provide systems that have been tested to show T Rating as indicated.
2. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
3. Watertightness: Provide systems that have been tested to show W Rating as indicated.
4. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

F. Smoke Barriers: Where through-penetration firestop systems are indicated in smoke barriers, provide through-penetration firestop systems with L Ratings of not more than 5.0 cfm per square foot of penetration opening at 0.30 inch of water for both ambient temperature and elevated temperature when tested in accordance with UL 1479.

2.04 FIRESTOPPING SYSTEMS

A. Firestopping: Any material meeting requirements.
1. Fire Ratings: See drawings for required systems and ratings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.

B. Remove incompatible materials that could adversely affect bond.

C. Install backing materials to prevent liquid material from leakage.

3.03 INSTALLATION

A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

B. Do not cover installed firestopping until inspected by authorities having jurisdiction.

C. Install labeling required by code.

3.04 FIELD QUALITY CONTROL

A. Independent Testing Agency: Inspection agency employed and paid by Owner, will examine penetration firestopping in accordance with ASTM E2174 and ASTM E2393.

B. Contractor shall employ and pay for services of an independent testing agency to perform specified inspections.

C. Inspect penetration sealed areas to ensure proper installation before concealing or enclosing areas, performed in accordance with ASTM E2174 and ASTM E2393.

D. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.05 **IDENTIFICATION**

A. Location: Permanently identify surfaces adjacent to and within 6 inches of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems.

B. Label: Pressure sensitive self-adhesive vinyl labels, with the following minimum information:
   1. The words "Warning - Through Penetration Firestop System - Do not Disturb. Notify Building Management of Any Damage."
   2. Listing agency's system number or designation.
   3. System manufacturer's name, product name/number.
   4. Installer's name.
   5. General contractor's name.
   6. Date of installation.

3.06 REPAIR

A. Perform under this Section patching and repairing of firestopping caused by cutting or penetration by other trades.

3.07 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.08 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 07 92 00
JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nonsag gunnable joint sealants.

B. Joint backings and accessories.

1.02 REFERENCE STANDARDS

A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.

B. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.

C. ASTM C834 - Standard Specification for Latex Sealants.

D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

E. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.

F. ASTM C1193 - Standard Guide for Use of Joint Sealants.

G. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants.

H. ASTM C1311 - Standard Specification for Solvent Release Sealants.

I. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.

J. ASTM C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.

K. SCAQMD 1168 - Adhesive and Sealant Applications.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical datasheets for each product to be used; include the following:
   1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
   2. List of backing materials approved for use with the specific product.
   3. Backing material recommended by sealant manufacturer.
   4. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
   5. Substrates the product should not be used on.
   6. Substrates for which use of primer is required.
   7. Installation instructions, including precautions, limitations, and recommended backing materials and tools.

B. Joint Sealant Schedule. Include the following information:
   1. Joint sealant application, joint location and designation.
   2. Joint sealand manufacturer and product name.
   3. Joint sealant formulation.
   4. Joint sealant color.

C. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.

D. Installation Plan: Submit at least four weeks prior to start of installation.

E. Preinstallation Field Adhesion Test Plan: Submit at least two weeks prior to start of installation.

F. Preinstallation Field Adhesion Test Reports: Submit filled out Preinstallation Field Adhesion Test Reports log within 10 days after completion of tests; include bagged test samples and photographic records.

G. Installation Log: Submit filled-out log for each length or instance of sealant installed.

H. Field Quality Control Log: Submit filled-out log for each length or instance of sealant installed, within 10 days after completion of inspections/tests; include bagged test samples and photographic records, if any.

I. Manufacturer's Installation Instructions: Indicate special procedures, surface preparation, and perimeter conditions requiring special attention.

J. Executed warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

B. Installer Qualifications: Company specializing in performing the work of this section and with at least three years of documented experience.

C. Preconstruction Laboratory Testing: Arrange for sealant manufacturer(s) to test each combination of sealant, substrate, backing, and accessories.
   1. Adhesion Testing: In accordance with ASTM C794.
   2. Compatibility Testing: In accordance with ASTM C1087.
   3. Deliver sufficient samples to manufacturer for testing.
   4. Report manufacturer's recommended corrective measures, if any, including primers or techniques not indicated in product data submittals.
   5. Testing is not required if sealant manufacturer provides data showing previous testing, not older than 24 months, that shows satisfactory adhesion, lack of staining, and compatibility.

D. Installation Plan: Include schedule of sealed joints, including the following:
   1. Installation Log Form: Include the following data fields, with known information filled out.
      a. Location on project.
      b. Substrates.
      c. Sealant used.
      d. Date of installation.
      e. Name of installer.
      f. Actual joint width; provide space to indicate maximum and minimum width.
      g. Actual joint depth to face of backing material at centerline of joint.
      h. Air temperature.

E. Preinstallation Field Adhesion Test Plan: Include destructive field adhesion testing of one sample of each combination of sealant type and substrate, except interior acrylic latex sealants, and include the following for each tested sample.
   1. Preinstallation Field Adhesion Test Log Form: Include the following data fields, with known information filled out.
      a. Substrate; if more than one type of substrate is involved in a single joint, provide two entries on form, for testing each sealant substrate side separately.
      b. Test date.
      c. Location on project.
      d. Sealant used.
      e. Stated movement capability of sealant.
      f. Test method used.
      g. Date of installation of field sample to be tested.
      h. Date of test.
      i. Copy of test method documents.

j. Age of sealant upon date of testing.
k. Test results, modeled after the sample form in the test method document.
l. Indicate use of photographic record of test.

F. Field Adhesion Test Procedures:
1. Allow sealants to fully cure as recommended by manufacturer before testing.
2. Have a copy of the test method document available during tests.
3. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
4. When performing destructive tests, also inspect the opened joint for proper installation characteristics recommended by manufacturer, and report any deficiencies.
5. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.

G. Field Adhesion Tests of Joints: Test for adhesion using most appropriate method in accordance with ASTM C1521, or another applicable method as recommended by manufacturer.

1.05 WARRANTY

A. Manufacturer Warranty: Provide manufacturer warranty for installed sealants and accessories that fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 JOINT SEALANT APPLICATIONS

A. Scope:
1. Exterior Joints:
a. Seal the following joints:
1) Wall expansion and control joints.
2) Joints between doors, windows, and other frames or adjacent construction.
3) Joints between different exposed materials.
2. Interior Joints:
a. Do not seal gaps and openings in gypsum board and suspended ceilings
b. Do not seal through-penetrations in sound-rated assemblies that are also fire-rated assemblies.
c. Seal the following joints:
1) Joints between door frames and window frames and adjacent construction.
2) In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, and piping penetrations.
3) In sound-rated wall and ceiling assemblies, seal joints between wall assemblies and ceiling assemblies; between wall assemblies and other construction; between ceiling assemblies and other construction.
3. Do Not Seal:
a. Intentional weep holes in masonry.
b. Joints indicated to be covered with expansion joint cover assemblies.
c. Joints where sealant is specified to be furnished and installed by manufacturer of product to be sealed.
d. Joints where sealant installation is specified in other sections.
e. Joints between suspended ceilings and walls.

2.02 JOINT SEALANTS - GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. Sealants and Primers: Provide products having lower volatile organic compound (VOC) content than indicated in SCAQMD 1168.

2.03 NONSAG JOINT SEALANTS

A. Non-Staining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
   1. Applications:
      a. Exterior joints between metal panels.
      b. Joints between glass.
      c. Control, expansion, and soft joints in concrete.
      d. Joints between metal frames and other materials.
      e. Interior perimeter joints of metal frames in exterior walls.
      f. Interior joints between countertops, backsplashes and wall surfaces.
      g. Other exterior joints for which no other sealant is indicated.
   2. Movement Capability: Plus and minus 50 percent, minimum.
   3. Nonstaining to Porous Stone: Nonstaining to light-colored natural stone when tested in accordance with ASTM C1248.
   4. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
   5. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
   6. Color: Match adjacent finished surfaces.
   7. Products:
      a. Dow; DOWSIL 790 Silicone Building Sealant: www.dow.com/#sle.
      b. Pecora Corporation; Pecora 890 NST (Non-Staining Technology): www.pecora.com/#sle.
      c. Sika Corporation; Sikasil WS-290: usa.sika.com/#sle.

B. Silicone Joint Sealant — Basis-of-Design Product: All-Sil by The Garland Company, Inc.; one-part, medium-modulus, non-corrosive, neutral-curing, high-performance silicone joint sealant; for metal curtain walls, copings, panel bedding, glazing details, and wet glazing on non-porous substrates including PVC, coated metal (including Kynar coated), plastics, styrofoam, and glass.
   1. Tensile Strength, ASTM D 412: 190 psi.
   2. Elongation, ASTM D 412: 650 percent.
   3. Hardness, Shore A, ASTM C 661: 15.
   4. Joint Movement Capability, ASTM C 719: Plus or minus 50 percent.
   5. Specific Gravity: 1.04.
   6. Tool Time (Initial Skin): 8 to 10 hours at 77 deg F (25 deg C), 50 percent relative humidity.
   7. VOC: 40 g/L.
   8. Color: As selected by Architect from manufacturer's full standard range.

C. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
   1. Applications:
      a. Joints between plumbing fixtures and wall surfaces
   2. Color: White.
   3. Products:
      a. Pecora Corporation; Pecora 898 NST (Non-Staining Technology): www.pecora.com/#sle.
      b. Sika Corporation; Sikasil GP: usa.sika.com/#sle.

D. Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single component; not expected to withstand continuous water immersion or traffic.
   1. Applications:
      a. Expansion joints in tile floors.

2. Movement Capability: Plus and minus 35 percent, minimum.
3. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
4. Color: Match adjacent finished surfaces.
5. Products:
    a. Master Builders Solutions: www.master-builders-solutions.com/en-us/#sle.
    b. Sika Corporation: www.usa.sika.com/#sle.
    c. Tremco Commercial Sealants & Waterproofing; Dymonic 100: www.tremcosealants.com/#sle.

E. Acrylic Emulsion Latex: Water-based; ASTM C834, single component, nonstaining, nonbleeding, nonsagging; not intended for exterior use.
1. Applications:
    a. Interior wall and ceiling control joints.
    b. Joints between door and window frames and wall surfaces.
    c. Other interior joints for which no other type of sealant is indicated.
2. Color: Standard colors matching finished surfaces, Type OP (opaque).
3. Grade: ASTM C834; Grade NF.
4. Products:
    a. Pecora Corporation; AC-20 +Silicone: www.pecora.com/#sle.
    b. Sherwin-Williams Company; White Lightning 3006 Siliconized Acrylic Latex Caulk: www.sherwin-williams.com/#sle.
    c. Tremco Commercial Sealants & Waterproofing; Tremflex 834: www.tremcosealants.com/#sle.

2.04 ACCESSORIES

A. Sealant Backing Materials, General: Materials placed in joint before applying sealants; assists sealant performance and service life by developing optimum sealant profile and preventing three-sided adhesion; type and size recommended by sealant manufacturer for compatibility with sealant, substrate, and application.

B. Sealant Backing Rod, Closed-Cell Type:
1. Cylindrical flexible sealant backings complying with ASTM C1330 Type C.
2. Size: 25 to 50 percent larger in diameter than joint width.

C. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.

D. Masking Tape: Self-adhesive, nonabsorbent, nonstaining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.

E. Joint Cleaner: Noncorrosive and nonstaining type, type recommended by sealant manufacturer; compatible with joint forming materials.

F. Primers: Type recommended by sealant manufacturer to suit application; nonstaining.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that joints are ready to receive work.

B. Verify that backing materials are compatible with sealants.

C. Verify that backer rods are of the correct size.

D. Preinstallation Adhesion Testing: Install a sample for each test location indicated in the test plan.
1. Test each sample as specified in PART 1 under QUALITY ASSURANCE article.
2. Notify Architect of date and time that tests will be performed, at least seven days in advance.
3. Record each test on Preinstallation Adhesion Test Log as indicated.

4. If any sample fails, review products and installation procedures, consult manufacturer, or take other measures that are necessary to ensure adhesion; retest in a different location; if unable to obtain satisfactory adhesion, report to Architect.
5. After completion of tests, remove remaining sample material and prepare joints for new sealant installation.

3.02 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.

B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.03 INSTALLATION

A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Provide joint sealant installations complying with ASTM C1193.

C. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.

D. Install bond breaker backing tape where backer rod cannot be used.

E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.

F. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.

G. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.04 FIELD QUALITY CONTROL

A. Perform field quality control inspection/testing as specified in PART 1 under QUALITY ASSURANCE article.

B. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

3.05 POST-OCCUPANCY

A. Post-Occupancy Inspection: Perform visual inspection of entire length of project sealant joints at a time that joints have opened to their greatest width, i.e., at low temperature in thermal cycle. Report failures immediately and repair them.

END OF SECTION

SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Non-fire-rated hollow metal doors and frames.

B. Thermally insulated hollow metal doors with frames.

1.02 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design.

B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors.

C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100).

D. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.

E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

F. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable.

G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

H. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.

I. ICC A117.1 - Accessible and Usable Buildings and Facilities.

J. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames.

K. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames.

L. NAAMM HMMA 840 - Guide Specifications for Receipt, Storage and Installation of Hollow Metal Doors and Frames.

M. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames.

N. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.

O. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames.

1.03 SUBMITTALS

A. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes.

B. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.

C. Samples: Submit two samples of metal, 2 by 2 inches in size, showing factory finishes, colors, and surface texture.

D. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.

B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Hollow Metal Doors and Frames:
1. Ceco Door, an Assa Abloy Group company: www.assaabloydss.com/#sle.
2. Curries, an Assa Abloy Group company: www.assaabloydss.com/#sle.
3. Fleming Door Products, an Assa Abloy Group company: www.assaabloydss.com/#sle.
4. Steelcraft, an Allegion brand: www.allegion.com/#sle.

2.02 PERFORMANCE REQUIREMENTS

A. Requirements for Hollow Metal Doors and Frames:
1. Steel Sheet: Comply with one or more of the following requirements; galvannealed steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
2. Accessibility: Comply with ICC A117.1 and ADA Standards.
3. Exterior Door Top Closures: Flush end closure channel, with top and door faces aligned.
4. Door Edge Profile: Manufacturers standard for application indicated.
5. Typical Door Face Sheets: Flush.
6. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturer's standard.
7. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
8. Zinc Coating for Typical Interior and/or Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvannealed) by the hot-dip process in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness, unless noted otherwise for specific hollow metal doors and frames.
a. Based on SDI Standards: Provide at least A40/ZF120 (galvannealed) when necessary, coating not required for typical interior door applications, and at least A60/ZF180 (galvannealed) for corrosive locations.

B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL DOORS

A. Door Finish: Factory primed and field finished.

B. Exterior Doors: Thermally insulated.
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
a. Level 2 - Heavy-duty.
b. Physical Performance Level B, 500,000 cycles; in accordance with ANSI/SDI A250.4.
c. Model 1 - Full Flush.
d. Door Face Metal Thickness: 18 gauge, 0.042 inch, minimum.

2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
3. Door Thickness: 1-3/4 inches, nominal.

C. Interior Doors, Non-Fire-Rated:
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
a. Level 2 - Heavy-duty.
b. Physical Performance Level B, 500,000 cycles; in accordance with ANSI/SDI A250.4.
c. Model 1 - Full Flush.
d. Door Face Metal Thickness: 18 gauge, 0.042 inch, minimum.
2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
3. Door Thickness: 1-3/4 inches, nominal.

2.04 HOLLOW METAL FRAMES

A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.

B. Frame Finish: Factory primed and field finished.

C. Exterior Door Frames: Full profile/continuously welded type.
1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness.
2. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.
3. Weatherstripping: Separate, see Section 08 71 00.

D. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
1. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.

2.05 FINISHES

A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.06 ACCESSORIES

A. Door Window Frames: Door window frames with glazing securely fastened within door opening.
1. Frame Material: 18 gauge, 0.0478 inch, galvanized steel.
2. Metal Finish: Gray polyester powder coating.

B. Glazing: As specified in Section 08 80 00, factory installed.

C. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.

D. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

C. Verify that finished walls are in plane to ensure proper door alignment.

3.02 PREPARATION

A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

3.03 INSTALLATION

A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.

B. Install fire rated units in accordance with NFPA 80.

C. Coordinate frame anchor placement with wall construction.

D. Install door hardware as specified in Section 08 71 00.

E. Comply with glazing installation requirements of Section 08 80 00.

F. Coordinate installation of electrical connections to electrical hardware items.

3.04 TOLERANCES

A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.

B. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.05 ADJUSTING

A. Adjust for smooth and balanced door movement.

3.06 SCHEDULE

A. Refer to Door and Frame Schedule on the drawings.

END OF SECTION

SECTION 08 11 16
ALUMINUM DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Glazed aluminum doors.

B. Aluminum frames.

C. Flush door panels.

1.02 REFERENCE STANDARDS

A. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum.

B. AAMA 611 - Specification for Anodized Architectural Aluminum.

C. ADA Standards - 2010 ADA Standards for Accessible Design.

D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

E. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

G. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).

H. ICC A117.1 - Accessible and Usable Buildings and Facilities.

1.03 SUBMITTALS

A. Product Data: Manufacturer's descriptive literature for each type of door; include information on fabrication methods.

B. Shop Drawings: Include elevations of each opening type.

C. Verification Samples: Two actual pieces of products in each finish specified, not less than 6 inches square or 6 inches long for linear components. For finishes subject to color variation, include not less than two samples illustrating extreme range to be anticipated.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with not less than five years of documented experience.

B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver aluminum components in manufacturer's standard protective packaging, palleted, crated, or banded together.

B. Inspect delivered components for damage and replace. Repaired components will not be accepted.

C. Store components in clean, dry, indoor area, under cover in manufacturer's packaging until installation.

D. Protect materials and finish from damage during handling and installation.

1.06 FIELD CONDITIONS

A. Do not begin installation of interior aluminum components until space has been enclosed and ambient thermal conditions are being maintained at levels consistent with final project requirements.

1.07 WARRANTY

A. Correct defective Work within a five year period after Date of Substantial Completion.

B. Manufacturer Warranty: Provide 10-year manufacturer warranty for defects in workmanship and materials. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Aluminum Doors and Frames:
   1. Arcadia, Inc: www.arcadiainc.com/#sle.
   2. Assa Abloy Frameworks: www.frameworks.com
   3. Cline Aluminum Doors, Inc: www.clinedoors.com/#sle.
   4. RACO Interior Products; www.racointeriors.com

2.02 DOORS AND FRAMES

A. Accessibility: Comply with ICC A117.1 and ADA Standards.

B. Glazed Aluminum Doors: Extruded aluminum tube frame, full glazed, with middle rail where scheduled; factory glazed.
   1. Thickness: 1-3/4 inches, nominal.
   2. Finish: Class I - Natural anodized.
   3. Texture: Smooth.
   4. Seals: Manufacturer's standard.
   5. Glazing: See Section 08 80 00.

C. Aluminum Frames for Doors, Sidelights, or Transoms: Extruded aluminum, non-thermally broken hollow or C-shaped sections; no steel components.
   1. Frame Depth: To fit wall thicknesses as indicated on drawings.
   2. Finish: Same as doors.
   3. Sidelight/Transom Glazing: See Section 08 80 00 .

D. Dimensions and Shapes: As indicated on drawings; dimensions indicated are nominal.
   1. Provide vision lites as indicated on drawings.
   2. Provide the following clearances:
      a. Hinge and Lock Stiles: 1/8 inch.
      b. Between Meeting Stiles: 1/4 inch.
      c. At Top Rail and Bottom Rail: 1/8 inch.

2.03 COMPONENTS

A. Flush Door Panels: Without visible seams on face sheet.
   1. Framing and Hardware Backup: Extruded aluminum tubing, 1/8 inch minimum thickness.
   2. Perimeter Edges: Extruded aluminum cap.
   3. Laminating Adhesive: Manufacturer's standard low-VOC materials.

B. Frames: Extruded aluminum shapes, not less than 0.062 inch thick, reinforced at hinge and strike locations.
   1. Corner Brackets: Extruded aluminum, fastened with stainless steel screws.
   2. Trim: Extruded aluminum, not less than 0.062 inch thick, removable snap-in type without exposed fasteners.

C. Vision Lites: Extruded aluminum framed, gasket glazed.
   1. Glazing: See Section 08 80 00.

2.04 MATERIALS

A. Aluminum Sheet: ASTM B209/B209M, alloy 5005, temper H14, stretcher leveled.

B. Extruded Aluminum: ASTM B221 (ASTM B221M), alloy 6063, temper T5, or alloy 6463, temper T5.

2.05 FINISHES

A. Class I Natural Anodized Finish: Clear anodic coating; AAMA 611 AA-M12C22A41, minimum dry film thickness (DFT) of 0.7 mils, 0.0007 inch.

B. Color: As indicated on drawings.

C. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.06 ACCESSORIES

A. Fasteners: Aluminum, non-magnetic stainless steel, or other material warranted by manufacturer as non-corrosive and compatible with aluminum components.

B. Brackets and Reinforcements: Manufacturer's high-strength aluminum units where feasible, otherwise, non-magnetic stainless steel or steel hot-dip galvanized in compliance with ASTM A123/A123M.

C. Bituminous Coating: Cold-applied asphaltic mastic, compounded for 30-mil thickness per coat.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that wall surfaces and openings are ready to receive frames and are within tolerances specified in manufacturer's instructions.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Perform cutting, fitting, forming, drilling, and grinding of frames as required for project conditions.

B. Replace components with damage to exposed finishes.

C. Separate dissimilar metals to prevent electrolytic action between metals.

3.03 INSTALLATION

A. Install doors and frames in accordance with manufacturer's instructions and approved shop drawings.

B. Set frames plumb, square, level, and aligned to receive doors. Anchor frames to adjacent construction in strict accordance with manufacturer's recommendations and within specified tolerances.

C. Where aluminum surfaces contact metals other than stainless steel, zinc, or small areas of white bronze, protect from direct contact by painting dissimilar metal with heavy coating of bituminous paint.

D. Hang doors and adjust hardware to achieve specified clearances and proper door operation.

E. Install door hardware. See Section 08 71 00.

F. Install glazing; set glazing stops and glazing gaskets flush with face of door or frame.

G. Comply with glazing installation requirements. See Section 08 80 00.

3.04 CLEANING

A. Upon completion of installation, thoroughly clean door and frame surfaces in accordance with AAMA 609 & 610.

B. Do not use abrasive, caustic, or acid cleaning agents.

3.05 PROTECTION

A. Protect products of this section from damage caused by subsequent construction until Date of Substantial Completion.

B. Replace damaged or defective components that cannot be repaired to a condition indistinguishable from undamaged components.

END OF SECTION

SECTION 08 31 00
ACCESS DOORS AND PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall- and ceiling-mounted access units.

1.02 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design.

B. ANSI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames..

C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.

D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

E. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

F. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

G. ASTM A879/A879M - Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.

H. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable.

I. ITS (DIR) - Directory of Listed Products.

J. UL (FRD) - Fire Resistance Directory.

1.03 SUBMITTALS

A. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.

B. Shop Drawings: Indicate exact position of each access door and/or panel unit.

C. Manufacturer's Installation Instructions: Indicate installation requirements.

PART 2 PRODUCTS

2.01 WALL- AND CEILING-MOUNTED ACCESS UNITS

A. Manufacturers:
   1. Activar Construction Products Group: www.activarcpg.com/#sle.
   2. Babcock-Davis: www.babcockdavis.com/#sle.
   3. Larsen's Manufacturing
   4. Milcor, Inc[<>]: www.milcorinc.com.
   5. Nystrom, Inc: www.nystrom.com/#sle.

B. Flush Wall- and Ceiling-Mounted Units: Factory-fabricated door and frame, fully assembled units with corner joints welded, filled and ground flush; square and without rack or warp; coordinate requirements with type of installation assembly being used for each unit.
   1. Material: Steel.
   2. Style: Exposed frame with door surface flush with frame surface.
      a. Gypsum Board Mounting Criteria: Use drywall bead type frame.
   3. Non-Rated Door Style: Single thickness with rolled or turned in edges.
   4. Fire-Rated Door Style: Double-skin sheet metal with core of mineral-fiber insulation.
   5. Frames: 16-gauge, 0.0598-inch minimum thickness.

6. Units in Fire-Rated Assemblies: Fire rating as required by applicable code for fire-rated assembly that access doors are being installed.
    a. Provide products listed by ITS (DIR) or UL (FRD) as suitable for purpose indicated.
    b. Provide certificate of compliance from authorities having jurisdiction indicating approval of fire rated doors.
7. Finish:
    a. Ceiling Locations: Steel, primed
    b. Wall Locations: Stainless Steel, No. 4 Finish.
8. Door/Panel Size: As indicated on the drawings.
9. Hardware:
    a. Hardware for Fire-Rated Units: As required for listing.
    b. Hinges for Non-Fire-Rated Units: Concealed, constant force closure spring type.
    c. Latch/Lock: Tamperproof tool-operated cam latch.

2.02 MATERIALS

A. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M.

B. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666/A666M, Type 304.

C. Frame Anchors: Same material as door face.

D. Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M.

2.03 FINISHES

A. Primer: Rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that rough openings are correctly sized and located.

B. Begin installation only after substrates have been properly prepared, and if the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to proceeding with this work.

B. Prepare surfaces using methods recommended by manufacturer for applicable substrates in accordance with project conditions.

3.03 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Install frames plumb and level in openings, and secure units rigidly in place.

C. Position units to provide convenient access to concealed equipment when necessary.

3.04 FIELD QUALITY CONTROL

A. Non-Conforming Work: Remove and replace panels or frames that are warped, bowed, or otherwise damaged.

3.05 ADJUSTING

A. Adjust hardware and panels after installation for proper operation.

END OF SECTION

SECTION 08 43 13
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aluminum-framed storefront, with vision glass.

B. Aluminum doors and frames.

C. Weatherstripping.

1.02 REFERENCE STANDARDS

A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site.

B. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems.

C. AAMA 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems.

D. AAMA 611 - Specification for Anodized Architectural Aluminum.

E. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.

F. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.

G. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

H. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

I. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).

J. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

K. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

L. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

M. ASTM E783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.

N. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.

O. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with installation of other components that comprise the exterior enclosure.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.04 SUBMITTALS

A. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.

B. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.

C. Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.

D. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.

E. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Handle products of this section in accordance with AAMA CW-10.

B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.07 FIELD CONDITIONS

A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.08 WARRANTY

A. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Aluminum-Framed Storefronts:
   1. Kawneer North America: www.kawneer.com/#sle.
   2. Oldcastle BuildingEnvelope: www.oldcastlebe.com/#sle.
   3. Trulite Glass & Aluminum Solutions, LLC: www.trulite.com/#sle.
   4. YKK AP America, Inc: www.ykkap.com/commercial/#sle.

2.02 ALUMINUM-FRAMED STOREFRONT

A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
   1. Glazing Position: Centered (front to back).
   2. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.
   3. Finish: Superior performing organic coatings.
      a. Factory finish all surfaces that will be exposed in completed assemblies.
      b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
   4. Finish Color: As selected by Architect from manufacturer's standard line.
   5. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
   6. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.

7. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
8. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
9. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
10. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
11. Preparation for Window Treatments: Provide reinforced interior horizontal head rail.

B. Performance Requirements
1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
   a. Design Wind Loads: Comply with requirements of ASCE 7.
   b. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
2. Water Penetration Resistance on Manufactured Assembly: No uncontrolled water on interior face, when tested in accordance with ASTM E331 at pressure differential of 8 psf.
3. Air Leakage: 0.06 cfm/sq ft maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf pressure difference.
4. Condensation Resistance Factor of Framing: 60, minimum, measured in accordance with AAMA 1503.

2.03 COMPONENTS

A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
1. Framing members for interior applications need not be thermally broken.
2. Glazing Stops: Flush.
3. Product: Trifab Versaglaze 451T by Kawneer.

B. Glazing: See Section 08 80 00.

C. Swing Doors: Glazed aluminum.
1. Performance Requirements: Same as system in which it is installed.
2. Member Wall Thickness: 0.125 inch
3. Top Rail: 5 inches wide.
4. Vertical Stiles: 3-1/2 inches wide.
5. Bottom Rail: 10 inches wide.
6. Glazing Stops: Square.
7. Finish: Same as Storefront and Curtainwall.
8. Product: Insulpour 350T Thermal Entrances by Kawneer.

2.04 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Sheet Aluminum: ASTM B209/B209M.

C. Fasteners: Stainless steel.

D. Exposed Flashings: Aluminum sheet, 20 gauge, 0.032 inch minimum thickness; finish to match framing members.

E. Sealant for Setting Thresholds: Non-curing butyl type.

F. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

G. Glazing Accessories: See Section 08 80 00.

2.05 FINISHES

A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.

2.06 HARDWARE

A. For each door, include weatherstripping, sill sweep strip, and threshold.

B. Other Door Hardware: See Section 08 71 00.

C. Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.

D. Sill Sweep Strips: Resilient seal type, retracting, of neoprene; provide on all doors.

E. Threshold: Extruded aluminum, one piece per door opening, ribbed surface; provide on all doors.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and method of attachment with other work.

B. Verify that storefront wall openings and adjoining water-resistive and/or air barrier seal materials are ready to receive work of this section.

3.02 INSTALLATION

A. Install wall system in accordance with manufacturer's instructions.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.

G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.

H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

I. Set thresholds in bed of sealant and secure.

J. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inch per 3 feet non-cumulative or 0.06 inch per 10 feet, whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.04 FIELD QUALITY CONTROL

A. Water-Spray Test: Provide water spray quality test of installed storefront components in accordance with AAMA 501.2 during construction process and before installation of interior finishes.

1. Perform a minimum of two tests in each designated area as indicated on drawings.

2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.

B. Provide field testing of installed storefront system by independent laboratory in accordance with AAMA 503 during construction process and before installation of interior finishes.
   1. Perform a minimum of two tests in each designated area as indicated on drawings.
   2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.
   3. Field test for water penetration in accordance with ASTM E1105 with uniform static air pressure difference (Procedure A) not less than 4.18 psf.
      a. Maximum allowable rate of water penetration in 15-minute test is 0.5 ounce that is not contained in an area with provisions to drain to exterior, or collected on surface of interior horizontal framing member.
   4. Field test for air leakage in accordance with ASTM E783 with uniform static air pressure difference of 1.57 psf.
      a. Maximum allowable rate of air leakage is 0.09 cfm/sq ft.

3.05 ADJUSTING

A. Adjust operating hardware for smooth operation.

3.06 CLEANING

A. Remove protective material from pre-finished aluminum surfaces.

B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, and take care to remove dirt from corners and to wipe surfaces clean.

3.07 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION

SECTION 08 44 13
GLAZED ALUMINUM CURTAIN WALLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aluminum-framed curtain wall, with vision glazing and infill panels.

1.02 REFERENCE STANDARDS

A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site.

B. AAMA 501.1 - Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure.

C. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems.

D. AAMA 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems.

E. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum.

F. AAMA 611 - Specification for Anodized Architectural Aluminum.

G. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.

H. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.

I. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

J. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

K. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).

L. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

M. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

N. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

O. ASTM E547 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference.

P. ASTM E783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.

Q. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with installation of other components that comprise the exterior enclosure.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.04 SUBMITTALS

A. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.

B. Samples: Submit two samples 6 by 6 inches in size illustrating finished aluminum surface, glazing, and glazing materials.

C. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.

D. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.

E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Handle products of this section in accordance with AAMA CW-10.

B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.07 FIELD CONDITIONS

A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.08 WARRANTY

A. Manufacturer Warranty: Provide 5-year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units. Complete forms in Owner's name and register with installer.

B. Finish Warranty: Provide 5-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Glazed Aluminum Curtain Walls Manufacturers:
1. Kawneer North America: www.kawneer.com/#sle.
2. Oldcastle Building Envelope: www.oldcastlebe.com/#sle.
3. Trulite Glass & Aluminum Solutions, LLC; Curtain Wall SB750: www.trulite.com/#sle.
4. YKK AP America, Inc: www.ykkap.com/commercial/#sle.

2.02 CURTAIN WALL

A. Aluminum-Framed Curtain Wall: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
1. Outside glazed, with pressure plate and mullion cover.
2. Fabrication Method: Field fabricated stick system.
3. Glazing Method: Field glazed system.
4. Vertical Mullion Face Width: 2-1/2 inches.
5. Vertical Mullion Depth From Face of Glazing to Back of Frame: 6 or 7-1/2 inches, as indicated on drawings..

6. Finish: Class I natural anodized.
    a. Factory finish surfaces that will be exposed in completed assemblies.
    b. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
7. Provide flush joints and corners, weathersealed, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for imposed loads.
8. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
9. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.

B. Structural Performance Requirements: Design and size components to withstand the following load requirements without damage or permanent set.
1. Design Wind Loads: Comply with the requirements of ASCE 7
    a. Member Deflection: For spans less than 13 feet 6 inches, limit member deflection to flexure limit of glass in any direction, and maximum of 1/175 of span or 3/4 inch, whichever is less and with full recovery of glazing materials.
2. Movement: Accommodate the following movement without damage to components or deterioration of seals:
    a. Expansion and contraction caused by 180 degrees F surface temperature.
    b. Expansion and contraction caused by cycling temperature range of 170 degrees F over a 12 hour period.
    c. Movement of curtain wall relative to perimeter framing.
    d. Deflection of structural support framing, under permanent and dynamic loads.

C. Water Penetration Resistance on Manufactured Assembly: No uncontrolled water on indoor face when tested as follows:
1. Test Pressure Differential: 8 psf.

D. Air Leakage: 0.09 cfm/sq ft maximum leakage of wall area when tested in accordance with ASTM E283/E283M at 6.24 psf pressure difference across assembly.

2.03 COMPONENTS

A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
1. Cross-Section: As indicated on drawings.

B. Glazing: See Section 08 80 00.

C. Doors: Section 08 43 13 Aluminum Framed Storefronts

2.04 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Sheet Aluminum: ASTM B209/B209M.

C. Fasteners: Stainless steel; type as required or recommended by curtain wall manufacturer.

D. Exposed Flashings: Aluminum sheet, 20-gauge, 0.032-inch minimum thickness; finish to match framing members.

E. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

F. Glazing Accessories: See Section 08 80 00.

2.05 FINISHES

A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and method of attachment with other related work.

B. Verify that curtain wall openings and adjoining water-resistive and air barrier seal materials are ready to receive work of this section.

C. Verify that anchorage devices have been properly installed and located.

3.02 INSTALLATION

A. Install curtain wall system in accordance with manufacturer's instructions.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.

G. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

H. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inch per 3 feet noncumulative or 0.5 inches per 100 feet, whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

C. Sealant Space Between Curtain Wall Mullions and Adjacent Construction: Maximum of 3/4 inch and minimum of 1/4 inch.

3.04 FIELD QUALITY CONTROL

A. Water-Spray Test: Provide water spray quality test of installed curtain wall components in accordance with AAMA 501.2 during construction process and before installation of interior finishes.
   1. Perform a minimum of two tests in each designated area as indicated on drawings.
   2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.

B. Provide field testing of installed curtain wall system by independent laboratory in accordance with AAMA 503 during construction process and before installation of interior finishes.
   1. Perform a minimum of two tests in each designated area as indicated on drawings.
   2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.
   3. Field test for water penetration in accordance with ASTM E1105 with uniform static air pressure difference (Procedure A) not less than 4.18 psf.
      a. Maximum allowable rate of water penetration in 15-minute test is 0.5 ounce that is not contained in an area with provisions to drain to exterior, or collected on surface of interior horizontal framing member.
   4. Field test for air leakage in accordance with ASTM E783 with uniform static air pressure difference of 1.57 psf.
      a. Maximum allowable rate of air leakage is 0.09 cfm/sq ft.

C. Repair or replace curtain wall components that have failed designated field testing, and retest to verify performance complies with specified requirements.

3.05 ADJUSTING

A. Adjust operating sash for smooth operation.

3.06 CLEANING

A. Remove protective material from pre-finished aluminum surfaces.

B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, take care to remove dirt from corners, and wipe surfaces clean.

C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

END OF SECTION

SECTION 08 80 00
GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Insulating glass units.

B. Glazing units.

C. Plastic films.

D. Glazing compounds.

1.02 REFERENCE STANDARDS

A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.

B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.

C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.

D. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.

E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

F. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.

G. ASTM C1193 - Standard Guide for Use of Joint Sealants.

H. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.

I. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings.

J. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation.

K. GANA (SM) - GANA Sealant Manual.

L. NFRC 100 - Procedure for Determining Fenestration Product U-factors.

M. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.

N. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by each of the affected installers.

1.04 SUBMITTALS

A. Product Data on Insulating Glass Unit and Glazing Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.

B. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.

C. Samples: Submit two samples of glass units, showing coloration.

D. Certificate: Certify that products of this section meet or exceed specified requirements.

E. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain glass and fabricated glass products through one source from a single manufacturer for each glass type.

B. Perform Work in accordance with GANA (GM) and GANA (SM) for glazing installation methods.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years of documented experience.

D. Installer Qualifications: Company specializing in performing work of type specified, with minimum 3 years of documented experience.

1.06 FIELD CONDITIONS

A. Do not install glazing when ambient temperature is less than 40 degrees F.

B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.07 WARRANTY

A. Insulating Glass Units: Provide a five (5) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.

B. Low-e Coating: Provide a ten (10) year warranty to include coverage for deterioration of low-e coating and replacement of same.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
   1. Design Pressure: Calculated in accordance with ASCE 7.
   2. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
   3. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
   4. Glass thicknesses listed are minimum.

B. Weather-Resistive Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure water-resistive barrier, vapor retarder, and/or air barrier.

C. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
   1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 7 computer program.
   2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 7 computer program.
   3. Solar Optical Properties: Comply with NFRC 300 test method.

2.02 GLASS MATERIALS

A. Float Glass: Provide float glass based glazing unless otherwise indicated.
   1. Kind HS - Heat-Strengthened Type: Complies with ASTM C1048.
   2. Kind FT - Fully Tempered Type: Complies with ASTM C1048.
   3. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.

2.03 INSULATING GLASS UNITS

A. Insulating Glass Units: Types as indicated.

1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
3. Warm-Edge Spacers: Closed cell polymer foam warm-edge technology design.
   a. Spacer Width: As required for specified insulating glass unit.
   b. Spacer Height: Manufacturer's standard.
4. Spacer Color: Black.
5. Edge Seal:
   a. Single-Sealed System: Provide silicone, polysulfide, or polyurethane sealant as seal applied around perimeter.
   b. Color: Black.
6. Purge interpane space with dry air, hermetically sealed.

B. Insulating Glass Units: Vision glass, double glazed.
1. Basis of design product: Vitro; Solarban 90 on Pacifica + Clear
2. Outboard Lite: Fully tempered float glass, fully tempered where indicated or required by code, 1/4 inch thick, minimum.
   a. Tint: Vitro Solarban Pacifica.
   b. Coating: Low-E (passive type), on #2 surface.
3. Inboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
   a. Tint: Clear.
4. Visible Light Transmittance (VLT): 24 percent, nominal.
5. Solar Heat Gain Coefficient (SHGC): 0.17, nominal.

2.04 GLAZING UNITS

A. Monolithic Interior Vision Glazing:
1. Applications: Interior glazing unless otherwise indicated.
2. Glass Type: Fully tempered float glass.
3. Tint: Clear.
4. Thickness: 1/4 or 1/2 inch, as indicated on drawings.

B. Security Glazing: Laminated glass.
1. Applications: All interior glazing not otherwise indicated.

2.05 PLASTIC FILMS

A. Decorative Plastic Film: Polyvinyl butyral (PVB) type.
1. Application: Locations as indicated on drawings.
2. Series Type: Frost.
3. Color: To be selected.

2.06 GLAZING COMPOUNDS

A. Polysulfide Sealant: Two component; chemical curing, nonsagging type; ASTM C920 Type M, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; color as selected.

B. Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; nonbleeding, nonstaining; ASTM C920 Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; color as selected.

2.07 ACCESSORIES

A. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch by width of glazing rabbet space minus 1/16 inch by height to suit glazing method and pane weight and area.

B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Minimum 3 inch long by one half the height of the glazing stop by thickness to suit application, self adhesive on one face.

C. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.

D. Glazing Clips: Manufacturer's standard type.

2.08 FABRICATION

A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Orient pattern and draw of glass pieces in same direction. Place waves in sheet glass parallel to floor.

C. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with outdoor and indoor faces.

D. Grind smooth and polish exposed glass edges and corners.

E. Tinted Glass: Cut clean to avoid edge stress. Nipping will not be permitted.

F. Tempered and Heat Strengthened Glass: Fabricate each light before treatment. Cut to size, provide holes and cutouts required for accessories and other work that is attached to glass, finish edges.
   1. Treat heat strengthened and tempered glass by horizontal process in such a manner as to have roller distortion in a horizontal direction as installed n the building.
   2. Identify tempered glass with a permanent non-removable label.

G. Glazing Gaskets:
   1. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
   2. Except for outside glazed systems, glazing gaskets are to have factory molded corners inside and out and shipped to the destination in full gasket “frames”.

PART 3 EXECUTION

3.01 VERIFICATION OF CONDITIONS

A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.

B. Verify that the minimum required face and edge clearances are being provided.

C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.

D. Verify that sealing between joints of glass framing members has been completed effectively.

E. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.

B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

3.03 INSTALLATION, GENERAL

A. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.

B. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.

C. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.

D. Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.

E. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.

F. Prevent glass from contact with any contaminating substances that may be the result of construction operations such as, and not limited to the following; weld splatter, fire-safing, plastering, mortar droppings, and paint.

3.04 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

A. Application - Exterior and/or Interior Glazed: Set glazing infills from either the exterior or the interior of the building.

B. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.

C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.

D. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.05 INSTALLATION - WET GLAZING METHOD (COMPOUND AND COMPOUND)

A. Application - Interior Glazed: Set glazing infills from the interior of the building.

B. Install glazing resting on setting blocks. Install applied stop and center pane by use of spacer shims at 24 inch centers, kept 1/4 inch below sight line.

C. Locate and secure glazing pane using glazers' clips.

D. Fill gaps between glazing and stops with glazing compound until flush with sight line. Tool surface to straight line.

3.06 FIELD QUALITY CONTROL

A. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.

B. Monitor and report installation procedures and unacceptable conditions.

3.07 CLEANING

A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.

B. Remove nonpermanent labels immediately after glazing installation is complete.

C. Clean glass and adjacent surfaces after sealants are fully cured.

D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.08 PROTECTION

A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.

B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION

SECTION 09 05 61
COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section applies to floors identified in Contract Documents that are receiving the following types of floor coverings:
   1. Resilient tile and sheet.
   2. Thin-set ceramic tile and stone tile.

B. Removal of existing floor coverings.

C. Preparation of new and existing concrete floor slabs for installation of floor coverings.

D. Testing of concrete floor slabs for moisture and alkalinity (pH).

E. Remediation of concrete floor slabs due to unsatisfactory moisture or alkalinity (pH) conditions.
   1. Contractor shall perform all specified remediation of concrete floor slabs. If such remediation is indicated by testing agency's report and is due to a condition not under Contractor's control or could not have been predicted by examination prior to entering into the contract, a contract modification will be issued.

F. Remedial floor coatings.

1.02 REFERENCE STANDARDS

A. ASTM D4259 - Standard Practice for Preparation of Concrete by Abrasion Prior to Coating Application.

B. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.

C. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

D. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

E. RFCI (RWP) - Recommended Work Practices for Removal of Resilient Floor Coverings.

1.03 SUBMITTALS

A. Visual Observation Report: For existing floor coverings to be removed.

B. Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used; showing:
   1. Moisture and alkalinity (pH) limits and test methods.
   2. Manufacturer's required bond/compatibility test procedure.

C. Remedial Materials Product Data: Manufacturer's published data on each product to be used for remediation.

D. Testing Agency's Report:
   1. Description of areas tested; include floor plans and photographs if helpful.
   2. Summary of conditions encountered.
   3. Moisture and alkalinity (pH) test reports.
   4. Copies of specified test methods.
   5. Recommendations for remediation of unsatisfactory surfaces.
   6. Product data for recommended remedial coating.
   7. Submit report to Architect.
   8. Submit report not more than two business days after conclusion of testing.

E. Adhesive Bond and Compatibility Test Report.

1.04 QUALITY ASSURANCE

A. Moisture and alkalinity (pH) testing shall be performed by an independent testing agency employed and paid by Contractor.

B. Contractor may perform adhesive and bond test with Contractor's own personnel or hire a testing agency.

C. Testing Agency Qualifications: Independent testing agency experienced in the types of testing specified.
   1. Submit evidence of experience consisting of at least 3 test reports of the type required, with project Owner's project contact information.

D. Contractor's Responsibility Relating to Independent Agency Testing:
   1. Provide access for and cooperate with testing agency.
   2. Confirm date of start of testing at least 10 days prior to actual start.
   3. Allow at least 4 business days on site for testing agency activities.
   4. Achieve and maintain specified ambient conditions.
   5. Notify Architect when specified ambient conditions have been achieved and when testing will start.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, handle, and protect products in accordance with manufacturer’s instructions and recommendations.

B. Deliver materials in manufacturer’s packaging; include installation instructions.

C. Keep materials from freezing.

1.06 FIELD CONDITIONS

A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 65 degrees F or more than 85 degrees F.

B. Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 40 percent and not more than 60 percent.

PART 2 PRODUCTS

2.01 MATERIALS

A. Patching Compound: Section 03 54 00 - Cast Underlayment.

B. Remedial Floor Coating, Two-Component: Single-layer coating resistant to water vapor transmission meeting flooring manufacturer's emission limits, resistant to alkalinity (pH) level found, and suitable for flooring adhesion without further treatment.
   1. Thickness: As required for application and in accordance with manufacturer's installation instructions.
   2. Use product recommended by testing agency.
   3. Products:
      a. ARDEX Engineered Cements; ARDEX MC RAPID: www.ardexamericas.com/#sle.
      b. H.B. Fuller Construction Products, Inc: www.tecspecialty.com/#sle.
      c. LATICRETE International, Inc; LATICRETE VAPOR BAN E: www.laticrete.com/#sle.
      d. Mapei Corporation; Planiseal VS: www.mapei.com/#sle.
      e. Maxxon Corporation; Maxxon MVP Two-Part Epoxy: www.maxxon.com/#sle.
      f. USG Corporation; Durock CoverPrep: www.usg.com/#sle.
      g. UZIN UTZ NORTH AMERICA, INC; UZIN PE 460 with UZIN PE 280: https://us.uzin.com/#sle.

PART 3 EXECUTION

3.01 CONCRETE SLAB PREPARATION

A. Perform following operations in the order indicated:
   1. Existing concrete slabs (on-grade and elevated) with existing floor coverings:
      a. Visual observation of existing floor covering, for adhesion, water damage, alkaline deposits, and other defects.
      b. Removal of existing floor covering.
   2. Existing concrete slabs with coatings or penetrating sealers/hardeners/dustproofers:
      a. Prepare surface according to recommendations of remedial coating manufacturer and according to ASTM D4259.
   3. Preliminary cleaning.
   4. Moisture vapor emission tests; 3 tests in the first 1000 square feet and one test in each additional 1000 square feet, unless otherwise indicated or required by flooring manufacturer.
   5. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
   6. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
   7. Specified remediation, if required.
   8. Patching, smoothing, and leveling, as required.
   9. Other preparation specified.
   10. Adhesive bond and compatibility test.
   11. Protection.

B. Remediations:
   1. Active Water Leaks or Continuing Moisture Migration to Surface of Slab: Correct this condition before doing any other remediation; re-test after correction.
   2. Excessive Moisture Emission or Relative Humidity: If an adhesive that is resistant to the level of moisture present is available and acceptable to flooring manufacturer, use that adhesive for installation of the flooring; if not, apply remedial floor coating or remedial sheet membrane over entire suspect floor area.
   3. Excessive Alkalinity (pH): If remedial floor coating is necessary to address excessive moisture, no additional remediation is required; if not, if an adhesive that is resistant to the level present is available and acceptable to the flooring manufacturer, use that adhesive for installation of the flooring; otherwise, apply a skim coat of specified patching compound over entire suspect floor area.

3.02 REMOVAL OF EXISTING FLOOR COVERINGS

A. Comply with local, State, and federal regulations and recommendations of RFCI (RWP), as applicable to floor covering being removed.

B. Dispose of removed materials in accordance with local, State, and federal regulations and as specified.

3.03 PRELIMINARY CLEANING

A. Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.

B. Do not use solvents or other chemicals for cleaning.

3.04 MOISTURE VAPOR EMISSION TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

C. Test in accordance with ASTM F1869 and as follows.

D. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.

E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 square feet per 24 hours.

F. Report: Report the information required by the test method.

3.05 INTERNAL RELATIVE HUMIDITY TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

C. Test in accordance with ASTM F2170 Procedure A and as follows.

D. Testing with electrical impedance or resistance apparatus may not be substituted for the specified ASTM test method, as the values determined are not comparable to the ASTM test values and do not quantify the moisture content sufficiently.

E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if any test value exceeds 75 percent relative humidity.

F. Report: Report the information required by the test method.

3.06 ALKALINITY TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. The following procedure is the equivalent of that described in ASTM F710, repeated here for the Contractor's convenience.
   1. Use a wide range alkalinity (pH) test paper, its associated chart, and distilled or deionized water.
   2. Place several drops of water on a clean surface of concrete, forming a puddle approximately 1 inch in diameter. Allow the puddle to set for approximately 60 seconds, then dip the alkalinity (pH) test paper into the water, remove it, and compare immediately to chart to determine alkalinity (pH) reading.
   3. Use of a digital pH meter with probe is acceptable; follow meter manufacturer's instructions.

C. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is over 10.

3.07 PREPARATION

A. See individual floor covering section(s) for additional requirements.

B. Comply with requirements and recommendations of floor covering manufacturer.

C. Fill and smooth surface cracks, grooves, depressions, control joints and other non-moving joints, and other irregularities with patching compound.

D. Do not fill expansion joints, isolation joints, or other moving joints.

3.08 ADHESIVE BOND AND COMPATIBILITY TESTING

A. Comply with requirements and recommendations of floor covering manufacturer.

3.09 APPLICATION OF REMEDIAL FLOOR COATING

A. Comply with requirements and recommendations of coating manufacturer.

3.10 APPLICATION OF REMEDIAL FLOOR TREATMENT

A. Comply with requirements and recommendations of treatment manufacturer.

3.11 PROTECTION

A. Cover prepared floors with building paper or other durable covering.

B. Use protective methods and materials, including temporary coverings, recommended in writing by MVE-control system manufacturer.

END OF SECTION

SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Performance criteria for gypsum board assemblies.

B. Metal stud wall framing.

C. Metal channel ceiling framing.

D. Acoustic insulation.

E. Gypsum sheathing.

F. Cementitious backing board.

G. Gypsum wallboard.

H. Joint treatment and accessories.

I. Textured finish system.

1.02 REFERENCE STANDARDS

A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members.

B. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data.

C. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing.

D. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members.

E. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units.

F. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units.

G. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

H. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.

I. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.

J. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.

K. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

L. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members.

M. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.

N. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board.

O. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.

P. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.

Q. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.

R. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.

S. ASTM C1280 - Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing.

T. ASTM C1325 - Standard Specification for Fiber-Mat Reinforced Cementitious Backer Units.

U. ASTM C1396/C1396M - Standard Specification for Gypsum Board.

V. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.

W. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

X. ASTM E413 - Classification for Rating Sound Insulation.

Y. GA-216 - Application and Finishing of Gypsum Panel Products.

Z. GA-600 - Fire Resistance and Sound Control Design Manual.

1.03 SUBMITTALS

A. Product Data:
   1. Provide data on metal framing, gypsum board, accessories, and joint finishing system.
   2. Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

B. Shop Drawings: Indicate special details associated with acoustic seals.

C. Test Reports: For stud framing products that do not comply with AISI S220 or ASTM C754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.

B. Store metal products to prevent corrosion.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C840 and GA-216.

B. Interior Partitions, Indicated as Acoustic: Provide completed assemblies with the following characteristics:
   1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

C. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
   1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
   2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

D. Fire Rated Assemblies: Provide completed assemblies as indicated on the Drawings

2.02 METAL FRAMING MATERIALS

A. Material and Product Requirements: AISI S201 and AISI S220.

B. Manufacturers - Metal Framing, Connectors, and Accessories:
   1. ClarkDietrich: www.clarkdietrich.com/#sle.
   2. MarinoWARE: www.marinoware.com/#sle.
   3. Telling Industries: www.tellingindustries.com/#sle.

C. Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf; minimum 22 gage.
   1. Studs: C-shaped with knurled or embossed faces.
   2. Ceiling Channels: C-shaped.
   3. Furring Members: Hat-shaped sections, minimum depth of 7/8 inch.
   4. Resilient Furring Channels: Single or double leg configuration; 1/2 inch channel depth.

D. Shaft Wall Studs and Accessories: Galvanized sheet steel.
   1. Products:
      a. Same manufacturer as other framing materials.

E. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.

F. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection and prevent rotation of studs while maintaining structural performance of partition.
   1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100.
   2. Material: ASTM A653/A653M steel sheet, SS Grade 50, with G60 hot-dip galvanized coating.
   3. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
   4. Provide mechanical anchorage devices as described above that accommodate deflection while maintaining the fire-resistance rating of the wall assembly.

G. Deflection and Firestop Track: Intumescent strip factory-applied to track flanges expands when exposed to heat or flames to provide a perimeter joint seal.

H. Nonstructural Framing Accessories:
   1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
   2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.

2.03 BOARD MATERIALS

A. Manufacturers - Gypsum-Based Board:
   1. CertainTeed Corporation: www.certainteed.com/#sle.
   2. Georgia-Pacific Gypsum: www.gpgypsum.com/#sle.
   3. National Gypsum Company : www.nationalgypsum.com
   4. USG Corporation: www.usg.com/#sle.

B. Gypsum Wallboard, Type X: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
   2. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
   3. Thickness:
      a. Vertical Surfaces: 5/8 inch.

C. Backing Board For Wet Areas: One of the following products:

1. Application:
   a. Surfaces behind tile in wet areas including shower surrounds, and shower ceilings.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. ANSI Cement-Based Board: Non-gypsum-based; aggregated Portland cement panels with glass fiber mesh embedded in front and back surfaces complying with ANSI A118.9 or ASTM C1325.
   a. Thickness: 5/8 inch.
   b. Products:
      1) CertainTeed Corporation; FiberCement BackerBoard: www.certainteed.com
      2) Custom Building Products; Wonderboard: www.custombuildingproducts.com/#sle.
      3) PermaBASE Building Products, LLC provided by National Gypsum Company; PermaBase Cement Board: www.goldbondbuilding.com/#sle.
      4) USG Corporation; Durock Cement Board : www.usg.com/#sle.

D. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
   1. Application: Vertical surfaces behind thinset tile, except in wet areas.
   2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   3. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
   4. Type X Thickness: 5/8 inch.
   5. Edges: Tapered.
   6. Products:
      a. CertainTeed Corporation; Diamondback Glassroc Tile Backer.
      b. Georgia-Pacific Gypsum; DensArmor Plus: www.gpgypsum.com/#sle.
      c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Fire-Shield Gypsum Board: www.goldbondbuilding.com/#sle.
      d. US Gypsum Corporation; USG Durock Glass-Mat Tile Backerboard.

E. Exterior Sheathing Board: Sizes to minimize joints in place; ends square cut.
   1. Application: Exterior sheathing, unless otherwise indicated.
   2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   3. Glass Mat Faced Sheathing: Glass mat faced gypsum substrate as defined in ASTM C1177/C1177M.
   4. Core Type: Type X, as indicated.
   5. Type X Thickness: 5/8 inch.
   6. Edges: Square.
   7. Glass Mat Faced Products:
      a. American Gypsum Company; M-Glass Exterior Sheathing Type X: www.americangypsum.com/#sle.
      b. CertainTeed Corporation; GlasRoc Type X Exterior Sheathing: www.certainteed.com/#sle.
      c. Georgia-Pacific Gypsum; DensGlass Sheathing: www.gpgypsum.com/#sle.
      d. Georgia-Pacific Gypsum; DensGlass Fireguard Sheathing: www.gpgypsum.com/#sle.
      e. National Gypsum Company; Gold Bond eXP Sheathing
      f. USG Corporation; Securock Brand UltraLight Glass-Mat Sheathing Firecode X 5/8 in. (15.9 mm): www.usg.com/#sle.

2.04 GYPSUM BOARD ACCESSORIES

A. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, unfaced. Thickness: 2 inch.
   1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.

2. Smoke Developed Index: 50 or less, when tested in accordance with ASTM E84.
3. Products:
   a. CertaPro AcoustaTherm Batts manufactured by CertainTeed Corporation: www.certainteed.com.
   b. Sound Control Batts manufactured by Johns Manville Corporation: www.jm.com.
   c. Sound Attenuation Batt manufactured by Owens Corning Corp: www.owenscorning.com.
   d. QuietTherm manufactured by Knauf Insulation: www.www.knaufusa.com.

B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
1. Products:
   a. Franklin International, Inc; Titebond Acoustical Smoke & Sound Sealant: www.titebond.com/#sle.
   b. Liquid Nails, a brand of PPG Architectural Coatings; AS-825 Acoustical Sound Sealant: www.liquidnails.com/#sle.

C. Finishing Accessories: ASTM C1047, extruded aluminum alloy (6063 T5) or rolled zinc, unless noted otherwise.
1. Types: As detailed or required for finished appearance.
2. Special Shapes: In addition to conventional corner bead and control joints, provide U-bead at exposed panel edges.
3. Products:
   a. Same manufacturer as framing materials.

D. Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic, galvanized steel, or rolled zinc, unless noted otherwise.

E. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
1. Paper Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.
2. Ready-mixed vinyl-based joint compound.
3. Chemical hardening type compound.

F. Textured Finish Materials: Latex-based compound; plain.

G. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.

H. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion-resistant.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.02 SHAFT WALL INSTALLATION

A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
1. Fasten runners to structure with short leg to finished side, using appropriate power-driven fasteners at not more than 24 inches on center.
2. Install studs at spacing required to meet performance requirements.

B. Shaft Wall Liner: Cut panels to accurate dimensions and install sequentially between special friction studs.
1. On walls over sixteen feet high, screw-attach studs to runners top and bottom.
2. Seal perimeter of shaft wall and penetrations with acoustical sealant.

3.03 FRAMING INSTALLATION

A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.

B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
   1. Level ceiling system to a tolerance of 1/1200.
   2. Laterally brace entire suspension system.
   3. Install bracing as required at exterior locations to resist wind uplift.

C. Studs: Space studs at 16 inches on center.
   1. Extend partition framing to structure where indicated and to ceiling in other locations.
   2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
   3. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.

D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.

E. Acoustic Furring: Install resilient channels at maximum 24 inches on center. Locate joints over framing members.

F. Furring for Fire-Resistance Ratings: Install as required for fire-resistance ratings indicated and to GA-600 requirements.

G. Blocking: Install treated wood blocking or sheet metal anchor plates in stud cavities for support of:
   1. Architectural Wood Casework
   2. Framed openings.
   3. Wall-mounted cabinets.
   4. Plumbing fixtures.
   5. Toilet partitions.
   6. Toilet accessories.
   7. Wall-mounted door hardware.
   8. Equipment
   9. Lighting Fixtures

3.04 ACOUSTIC ACCESSORIES INSTALLATION

A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

B. Acoustic Sealant: Install in accordance with manufacturer's instructions.
   1. Place one bead continuously on substrate before installation of perimeter framing members.
   2. Place continuous bead at perimeter of each layer of gypsum board and the following joint conditions:
      a. Partition ends abutting other materials.
      b. Partition tops abutting structure.
      c. Partition bottom abutting floor.
      d. Opening frame perimeter joint to abutting materials.
   3. Framed Openings: Seal gypsum board terminations in door and window frames.
   4. Seal around all penetrations by conduit, pipe, ducts, and rough-in boxes, except where firestopping is provided.

C. Acoustic Seal Tape: Use to close voids where finished end of gypsum board partition abuts a dissimilar material such as a metal mullion or frame. Apply continuous to the abutting

surface and install the gypsum board tight against it to provide compression along its entire length. Tape to form an acoustic, vision and light barrier.

3.05 BOARD INSTALLATION

A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.

C. Fire-Resistance-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.

D. Exterior Sheathing: Comply with ASTM C1280. Install sheathing vertically, with edges butted tight and ends occurring over firm bearing.
   1. Seal joints, cut edges, and holes with water-resistant sealant.

E. Coated Glass Mat Backer Board:
   1. Install at toilet rooms, janitor's closets, and ceramic tile substrate.

F. Installation on Metal Framing: Use screws for attachment of gypsum board except face layer of nonrated double-layer assemblies, which may be installed by means of adhesive lamination.

3.06 INSTALLATION OF TRIM AND ACCESSORIES

A. Control Joints: Place control joints consistent with lines of building spaces and as follows:
   1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
   2. Provide full-height vertical joint each door opening, locate at outside edge, hinge side of door frame.
   3. Maintain fire rated construction integrity at fire rated partitions.

B. Corner Beads: Install at external corners, using longest practical lengths.

C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

D. Moisture Guard Trim: Install on bottom edge of gypsum board throughout building.

3.07 JOINT TREATMENT

A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, embed and finish with setting type joint compound.

B. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.

C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
   1. Level 5: Walls and ceilings to receive semi-gloss or gloss paint finish and other areas specifically indicated.
   2. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
   3. Level 3: Walls to receive textured wall finish.
   4. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
   5. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.

D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
   1. Feather coats of joint compound so that camber is maximum 1/32 inch.

E. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

F. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

3.08 TEXTURE FINISH

A. Apply finish texture coating by means of spraying apparatus in accordance with manufacturer's instructions and to match approved sample.

3.09 PARTITION MARKINGS

A. Mark fire-rated partitions and smoke barriers with 3-inch-high upper case letters with 3/8 inch stroke stenciled in red paint.

B. Place markings 6-inches above ceilings both sides of partitions as follows:
   1. Centered over doors.
   2. Maximum 30 feet on center inverval and not less than 15 feet from end of partition.
   3. Lettering Copy (as applicable):
      a. "1-HOUR FIRE RATED-PROTECT ALL OPENINGS"
      b. "2-HOUR FIRE RATED-PROTECT ALL OPENINGS"
      c. "4-HOUR FIRE RATED-PROTECT ALL OPENINGS"
      d. "SMOKE BARRIER, _#_-HOUR FIRE RATED-PROTECT ALL OPENINGS" (with appropriate fire rating)

C. Mark point of partition type demarcation with 1 inch wide painted vertical line from ceiling line to bottom of structure at the following conditions:
   1. from rated partition type to non-rated partition type;
   2. from change in partition type rating.

3.10 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

3.11 PROTECTION

A. Protect installed gypsum board assemblies from subsequent construction operations.

END OF SECTION

SECTION 09 30 00
TILING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Tile for floor applications.

B. Tile for wall applications.

C. Non-ceramic trim.

1.02 REFERENCE STANDARDS

A. ANSI A108.19 - American National Standard Specifications for Interior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs by the Thin-Bed Method Bonded with Modified Dry-Set Cement Mortar or Improved Modified Dry-Set Cement Mortar.

B. ANSI A108.20 - American National Standard Specifications for Exterior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs.

C. ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive.

D. ANSI A118.4 - American National Standard Specifications for Modified Dry-Set Cement Mortar.

E. ANSI A118.6 - American National Standard Specifications for Standard Cement Grouts for Tile Installation.

F. ANSI A118.10 - American National Standard Specifications for Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation.

G. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation.

H. ANSI A137.1 - American National Standard Specifications for Ceramic Tile.

I. ASTM D4068 - Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane.

J. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by affected installers.

1.04 SUBMITTALS

A. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.

B. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, and setting details.

C. Samples:
   1. Mount tile and apply grout on two plywood panels, minimum 18 by 18 inches in size illustrating pattern, color variations, and grout joint size variations.

D. Installer's qualification statement.

E. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.

B. Installer Qualifications:

1. Company specializing in performing tile installation, with minimum of five years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.07 FIELD CONDITIONS

A. Do not install solvent-based products in an unventilated environment.

B. Maintain ambient and substrate temperature above 50 degrees F and below 100 degrees F during installation and curing of setting materials.

PART 2 PRODUCTS

2.01 TILE

A. Refer to drawings for basis of design products.

B. Manufacturers: All products of each type by the same manufacturer.

C. Ceramic Mosaic Tile: ANSI A137.1 standard grade.
1. Size: As scheduled.
2. Edges: Square.
3. Surface Finish: As scheduled.
4. Color: As indicated on drawings.

D. Glazed Wall Tile: ANSI A137.1 standard grade.
1. Size: As scheduled.
2. Edges: Cushioned.
3. Surface Finish: As scheduled.
4. Manufacturer, Pattern, and Color(s): As scheduled.

E. Natural Stone Tile:
1. Size: As scheduled.
2. Face: Smooth.
3. Edges: As scheduled.

2.02 TRIM AND ACCESSORIES

A. Trim: Finish as scheduled, style and dimensions as indicated on drawings, for setting using tile mortar or adhesive.
1. Applications: In areas indicated
2. Products:
a. Manhattan American Terrazzo Strip Company: www.manhattanamerican.com
b. Mapei Corporation: www.mapei.com/#sle.
c. Schluter-Systems; Schiene: www.schluter.com/#sle.

2.03 SETTING MATERIALS

A. Provide setting and grout materials from same manufacturer.

B. Latex-Portland Cement Mortar Bond Coat: ANSI A118.4.
1. Applications: Use this type of bond coat where indicated, and where no other type of bond coat is indicated.
a. Large Tile: Thinset, medium bed, non-sag mortat for installation of ceramic tile and stone no larger than 48 x 48 inches with a minimum of 330 psi bond strength to porcelain tile.
1) H.B. Fuller Construction Products, Inc;TEC Ultimate Large Tile Mortar: www.tecspecialty.com.
2) Mapei CorporationUltraflex LFT: www.mapei.com/#sle.
3) Custom Building Products; ProLite Premium Rapid Setting Large Format Tile Mortar: www.custombuildingproducts.com/#sle.

b. Glass mosaic tile: Glass tile thinset with white latex modified mortar only.

2. Products:
   a. ARDEX Engineered Cements: www.ardexamericas.com/#sle.
   b. Custom Building Products: www.custombuildingproducts.com/#sle.
   c. H.B. Fuller Construction Products, Inc: www.tecspecialty.com/#sle.
   d. Mapei Corporation: www.mapei.com/#sle.

2.04 GROUTS

A. Provide setting and grout materials from same manufacturer.

B. Standard Grout: ANSI A118.6 standard cement grout.
   1. Applications: Use where indicated on drawings and where no other type of grout is indicated.
   2. Use sanded grout for joints 1/8 inch wide and larger; use unsanded grout for joints less than 1/8 inch wide.
   3. Color: As selected by Architect from manufacturer's full line.

C. Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.
   1. Applications: Use this type of grout at floor tile and shower receptors.
   2. Color: As selected by Architect from manufacturer's full line.

2.05 ACCESSORY MATERIALS

A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.
   1. Crack Resistance: No failure at 1/8 inch gap, minimum.
   2. Fluid or Trowel Applied Type:
      a. Thickness: 20 mils, maximum.
      b. Products:
         1) H.B. Fuller Construction Products, Inc: www.tecspecialty.com/#sle.
         2) LATICRETE International, Inc: www.laticrete.com/#sle.
         3) Mapei Corporation: www.mapei.com/#sle.
         4) Merkrete, by Parex USA, Inc: www.merkrete.com/#sle.

B. Waterproofing Membrane at Floors: Specifically designed for bonding to cementitious substrate under thick mortar bed or thin-set tile; complying with ANSI A118.10.
   1. Crack Resistance: No failure at 1/16-inch gap, minimum; comply with ANSI A118.12.
   2. Bonded Sheet Membrane Type:
      a. Material: Polyethylene sheet membrane with nonwoven fabric laminated to both sides, 20 to 30 mils thick, nominal.

C. Waterproofing Membrane Showers: Specifically designed for bonding to cementitious substrate under thick mortar bed or thin-set tile; complying with ANSI A118.10.
   1. Fluid or Trowel Applied Type:
      a. Material: Synthetic rubber.
      b. Thickness: 25 mils, minimum, dry film thickness.
   2. Mortar Bonded Sheet Type:
      a. Material: Chlorinated polyethylene sheet membrane with polyester fabric laminated to both sides, 30 mils, thick, minimum, complying with ASTM D4068.

D. Epoxy Haze Remover:
   1. Products:
      a. Mapei; Ultracare Epoxy Grout Haze Remover: www.mapei.com
      b. Miracle Sealants Company; Epoxy Grout Film Remover: www.miraclesealants.com.
      c. Custom Building Products; Non-Cement Grout Haze Remover by Aqua Mix: www.custombuildingproducts.com.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive tile.

B. Verify wall surfaces are smooth and flat within tolerances specified for that type of work, are dust-free, and are ready to receive tile.

C. Verify that subfloor surfaces are dust free and free of substances that could impair bonding of setting materials to subfloor surfaces.

D. Cementitious Subfloor Surfaces: Verify that substrates are ready for tiling installation by testing for moisture and alkalinity (pH).
   1. Test in accordance with Section 09 05 61.
   2. Obtain instructions if test results are not within limits recommended by tiling material manufacturer and setting material manufacturer.

E. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

A. Vacuum clean surfaces and damp clean.

B. Seal substrate surface cracks with filler.

C. Install crack isolation sheet at substrate cracks and control joints in accordance with manufacturer's instructions.

D. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.03 INSTALLATION - GENERAL

A. Install tile and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.20, manufacturer's instructions, and TCNA (HB) recommendations.

B. Lay tile to pattern indicated on drawings. Do not interrupt tile pattern through openings.

C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.

D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.

E. Form internal angles square and external angles bullnosed.

F. Install non-ceramic trim in accordance with manufacturer's instructions.

G. Metal Edge Trim:
   1. Install at exposed tile edges and edges abutting dissimilar materials.
   2. Install continuous metal edge trim at juncture of ceramic tile as noted on the Drawings.

H. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.

I. Sound tile after setting. Replace hollow sounding units.

J. Keep control and expansion joints free of mortar, grout, and adhesive.

K. Prior to grouting, allow installation to completely cure; minimum of 48 hours.

L. Grout tile joints unless otherwise indicated on drawings. Use standard grout unless otherwise indicated on drawings.

M. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, on ground, with standard grout, unless otherwise indicated on drawings.
   1. Use crack isolation sheet under all tile unless other underlayment is indicated.
   2. Where waterproofing membrane is indicated on drawings, install in accordance with TCNA (HB) Method F122, with latex-Portland cement grout, on ground.
   3. Where epoxy or furan grout is indicated on drawings, but not epoxy or furan bond coat, install in accordance with TCNA (HB) Method F115.

B. Install tile-to-tile floor movement joints in accordance with TCNA (HB) Method EJ171F.

3.05 INSTALLATION - WALL TILE

A. Over coated glass mat backer board on studs, install in accordance with TCNA (HB) Method W245.

3.06 CLEANING

A. Remove epoxy grout haze from tile surfaces using Epoxy Haze Remover according to manufacturer's directions.

B. Clean tile and grout surfaces.

3.07 PROTECTION

A. Cover tile floors with heavy Kraft paper, tape in place.

B. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION

SECTION 09 51 00
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended metal grid ceiling system.

B. Acoustical units.

1.02 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

B. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.

C. ASTM E1264 - Standard Classification for Acoustical Ceiling Products.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.

B. Do not install acoustical units until after interior wet work is dry.

1.04 SUBMITTALS

A. Shop Drawings: Indicate grid layout and related dimensioning.

B. Product Data: Provide data on suspension system components and acoustical units.

C. Samples: Submit two samples 6 by 6 inch in size illustrating material and finish of acoustical units.

D. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Extra Acoustical Units: Quantity equal to 5 percent of total installed. Round up quantities to the nearest box. Clearly and legibly lable boxes to indicate type.

1.05 QUALITY ASSURANCE

A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 FIELD CONDITIONS

A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acoustic Tiles/Panels:

1. Armstrong World Industries, Inc: www.armstrongceilings.com/#sle.
2. CertainTeed Corporation: www.certainteed.com/ceilings-and-walls/#sle.
3. USG Corporation: www.usg.com/ceilings/#sle.

2.02 ACOUSTICAL UNITS

A. Refer to drawings for basis of design

B. Acoustical Panels: Mineral fiber with membrane-faced overlay, with the following characteristics:
   1. Classification: ASTM E1264 Type A.
      a. Form: A2.2, wet formed.
      b. Pattern: G - smooth.
   2. Size: 24 by 24 inches.
   3. Panel Edge: As scheduled.
   4. Fire Hazard Classification: Class A.

2.03 SUSPENSION SYSTEMS

A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold-down clips, stabilizer bars, clips, and splices as required.
   1. Materials:
      a. Steel Grid: ASTM A653/A653M, G30 coating, unless otherwise indicated.

B. Exposed Suspension System: Hot-dip galvanized steel grid and cap.
   1. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
   2. Finish: Baked enamel.
   3. Color: White.
   4. Products: Same manufacturer as acoustical units

2.04 ACCESSORIES

A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.

B. Hanger Wire: 12 gauge, 0.08 inch galvanized steel wire.

C. Hold-Down Clips: Manufacturer's standard clips to suit application.

D. Perimeter Moldings: Same metal and finish as grid.

E. Acoustical Insulation: Specified in Section 07 21 00.

F. Acoustical Sealant for Perimeter Moldings: Non-hardening, non-skinning, for use in conjunction with suspended ceiling system.

G. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION

A. Install after major above-ceiling work is complete.

B. Coordinate the location of hangers with other work.

3.03 INSTALLATION - SUSPENSION SYSTEM

A. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

B. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.

C. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
   1. Use longest practical lengths.

2. Miter corners.
3. Apply flexible wall angle at round columns, free-form vertical surfaces and other irregular intersections.

D. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

E. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

F. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

G. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.

H. Do not eccentrically load system or induce rotation of runners.

3.04 INSTALLATION - ACOUSTICAL UNITS

A. Install acoustical units in accordance with manufacturer's instructions.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Fit border trim neatly against abutting surfaces.

D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

E. Install units after above-ceiling work is complete.

F. Cutting Acoustical Units:
1. Make field cut edges of same profile as factory edges.
2. Seal cut edges in accordance with manufacturer's instructions.

3.05 TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.

B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.06 CLEANING

A. Clean surfaces.

B. Replace damaged or abraded components.

END OF SECTION

SECTION 09 54 21
METAL PAN CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal pan ceilings.

B. Suspended metal support system and perimeter trim.

1.02 REFERENCE STANDARDS

A. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.

B. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

C. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions.

D. ASTM E1264 - Standard Classification for Acoustical Ceiling Products.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate work of this section with installation of mechanical and electrical components and with other construction activities affected by work of this section.

B. Preinstallation Meeting: Convene one week before starting work of this section.

1.04 SUBMITTALS

A. Product Data: Furnish for component profiles, materials, and perimeter and integral trim.

B. Shop Drawings: Indicate reflected ceiling plan, location of mechanical and electrical components, details of junction with dissimilar materials, and points of suspension.

C. Samples: Submit two samples 6 by 6 inch in size showing color and finish of components exposed to view.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Extra Metal Panels: Ten, standard dimensions.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept factory-finished products on site in manufacturer's unopened factory packaging; reject opened packages.

B. Protect factory-finished products from damage by storing in manufacturer's unopened factory packaging in dry storage area.

1.07 WARRANTY

A. Manufacturer Warranty: Provide 5-year manufacturer warranty; include coverage for corrosion resistance and discoloration of surface finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Pan Ceilings:

1. Armstrong World Industries, Inc: www.armstrongceilings.com/#sle.

2. Certainteed Architectural: www.certainteed.com/ceilings-and-walls/#sle.
3. USG Corporation: www.usg.com/#sle.

2.02 PERFORMANCE REQUIREMENTS

A. Design to support imposed loads of indicated elements without eccentric loading of supports. Where supported elements may induce rotation of ceiling system components, provide stabilizing reinforcement.

B. Design for maximum deflection of 1/360 of span.

2.03 METAL PAN CEILING ASSEMBLIES

A. Metal Pan Ceiling Systems: Panels, suspension members, trim, and accessories required to provide complete systems.
1. Exposed fasteners are not permitted.

B. Lay-in Panels: Metal-faced, prefinished panels with square edge for lay-in installation, allowing every panel access to ceiling plenum.
1. Classification: ASTM E1264, Class A, aluminum formed sheet.

C. Refer to drawings for basis of design products.
a. Pattern: G - smooth.
2. Panel Size: As indicated on drawings.
3. Finish: As indicated on drawings.

2.04 SUSPENSION SYSTEM

A. Metal Suspension Systems - General: Comply with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.

B. Exposed Suspension System: Hot-dip galvanized steel grid and cap.
1. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
2. Finish: Baked enamel.
3. Color: White.

2.05 ACCESSORIES

A. End Caps: Formed metal; same color and finish as sight-exposed surfaces of metal panels.

B. Support Channels, Carriers, and Hangers: Galvanized steel; size and type to suit application and ceiling system flatness requirement specified.

C. Suspension Wire: Size and type as required for application, seismic requirements, and ceiling system flatness requirement specified.
1. Concealed Suspension:
a. Suspension Wire: Steel, annealed, galvanized finish, 12 gauge, 0.0808-inch diameter.

D. Insulation: See Section 07 21 00.

E. Gypsum Board and Framing Materials: See Section 09 21 16.

F. Touch-Up Paint for Exposed Surfaces: Type and color to match pans and suspension system grid and trim elements.

2.06 FABRICATION

A. Shop cut metal panels to accommodate mechanical and electrical items.

B. Factory-form internal and external corners of same material, thickness, finish, and profile to match exposed metal panels; back brace internal corners.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that layout of hangers will not interfere with other work.

C. Verify that field measurements are as indicated on shop drawings.

D. Start of installation constitutes acceptance of project conditions.

3.02 PREPARATION

A. Coordinate the location of hangers with other work.

B. Provide hanger clips during steel deck erection. Provide additional hangers and inserts as required.

C. Install after major above-ceiling work is complete.

3.03 INSTALLATION - SUSPENSION SYSTEM:

A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented by this section.

B. Install hangers and inserts coordinated with overhead work. Provide additional hangers and supports as required.

C. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

D. Suspension System, Nonseismic: Hang suspension system independent of walls, columns, ducts, pipes, and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

E. Where ducts, facility services, or equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

F. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

G. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.

H. Do not eccentrically load system or induce rotation of runners.

I. Edge Moldings: Install at intersection of ceiling and vertical surfaces and penetrations, using components of maximum length, set level.
   1. Use longest practical lengths.

3.04 INSTALLATION - METAL PANS

A. Install panels, baffles, and other system components in accordance with manufacturer's instructions.

B. Butt interior end joints tight.

C. Provide expansion joints to accommodate plus or minus 1 inch movement and maintain visual closure.

D. Install edge moldings at junctions with other finishes and at vertical surfaces; use maximum piece lengths.

E. Install end caps at sight-exposed ends of panels.

F. Exercise care when site cutting sight-exposed finished components to ensure surface finish is not defaced.

3.05 TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.

B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

C. Maximum Variation From Dimensioned Position: 1/4 inch.

3.06 CLEANING

A. Clean surfaces.

B. Replace damaged or abraded components.

END OF SECTION

SECTION 09 65 00
RESILIENT FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Resilient tile flooring.

B. Resilient base.

C. Installation accessories.

1.02 REFERENCE STANDARDS

A. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.

B. ASTM F150 - Standard Test Method for Electrical Resistance of Conductive and Static Dissipative Resilient Flooring.

C. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.

D. ASTM F970 - Standard Test Method for Measuring Recovery Properties of Floor Coverings after Static Loading.

E. ASTM F1344 - Standard Specification for Rubber Floor Tile.

F. ASTM F1700 - Standard Specification for Solid Vinyl Floor in Modular Format such as Tile(s) or Plank(s).

G. ASTM F1861 - Standard Specification for Resilient Wall Base.

H. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

I. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

J. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.

1.03 SUBMITTALS

A. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.

B. Shop Drawings: Indicate seaming plans and floor patterns.

C. Verification Samples: Submit two samples, 12 by 12 inch in size illustrating color and pattern for each resilient flooring product specified.

D. Samples:
   1. Base: Two, 12 inch long, each type, color, and pattern
   2. Resilient flooring: Two 12 by 12 inch, each color and pattern

E. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of subfloor is acceptable.

F. Manufacturer's Qualification Statement.

G. Installer's Qualification Statement.

H. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum three years documented experience.

B. Installer Qualifications: Company specializing in installing specified flooring with minimum five years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.

B. Do not double stack pallets.

1.06 FIELD CONDITIONS

A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS

2.01 TILE FLOORING

A. Rubber Tile: Homogeneous, color and pattern throughout thickness.
   1. Minimum Requirements: Comply with ASTM F1344, of Class corresponding to type specified.
   2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
   3. Size: As indicated on drawings.
   4. Color: As indicated on drawings.

2.02 RESILIENT BASE

A. Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; top set Style A, Straight and Style B, Coved, as scheduled.
   1. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
   2. Height: As scheduled.
   3. Thickness: 0.125 inch.
   4. Length: Roll.
   5. Manufacturer, Finish, Color: As indicated on drawings.

2.03 ACCESSORIES

A. Subfloor Filler: Epoxy or Portland Cement type as recommended by adhesive material manufacturer; no gypsum-based filler products.

B. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.

C. Moldings, Transition and Edge Strips: As indicated on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.

C. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
   1. Test in accordance with Section 09 05 61.
   2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

3. Follow moisture and alkalinity remediation procedures in Section 09 05 61.

D. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

B. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.

C. Prohibit traffic until filler is fully cured.

D. Clean substrate.

E. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed.

3.03 INSTALLATION - GENERAL

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install in accordance with manufacturer's written instructions.

C. Adhesive-Applied Installation:
1. Spread only enough adhesive to permit installation of materials before initial set.
2. Place copper grounding strip in conductive adhesive and apply additional adhesive to top side of strip before installing static control flooring. Allow strip to extend beyond flooring in accordance with static control flooring manufacturer's instructions. Refer to Division 26 for grounding and bonding to building grounding system.
3. Fit joints and butt seams tightly.
4. Set flooring in place, press with heavy roller to attain full adhesion.

D. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.

E. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
1. Metal Strips: Attach to substrate before installation of flooring using stainless steel screws.
2. Resilient Strips: Attach to substrate using adhesive.

F. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

G. Install flooring in recessed floor access covers, maintaining floor pattern.

H. At movable partitions, install flooring under partitions without interrupting floor pattern.

I. Install feature strips where indicated.

3.04 INSTALLATION - TILE FLOORING

A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.

B. Lay flooring with joints and seams as indicated on drawings.

3.05 INSTALLATION - RESILIENT BASE

A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.

B. Wrap outside base corners; provide minimum 12-inch returns each side of corner. Cut back of base using standard cove base groover. Use heat-gun at base corner to ensure tight toe-to-floor joint.

C. Install base on solid backing. Bond tightly to wall and floor surfaces.

D. Job-Formed Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches

E. Scribe and fit to door frames and other interruptions.

3.06 FIELD QUALITY CONTROL

A. Manufacturer's Factory Representative, in the presence of the Owner's Representative or Architect, shall test completed static control tile flooring installation.
   1. Verify electrical resistance in accordance with ASTM F150.

3.07 CLEANING

A. Remove excess adhesive from floor, base, and wall surfaces without damage.

B. Clean in accordance with manufacturer's written instructions.

3.08 PROTECTION

A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION

SECTION 09 68 13
TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Carpet tile, fully adhered.

1.02 REFERENCE STANDARDS

A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials.

B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.

C. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.

1.03 SUBMITTALS

A. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.

B. Shop Drawings: Indicate layout of joints.

C. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.

D. Accessory Samples: Submit two 6 inch long samples of edge strip.

E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

F. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.

G. Operation and Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum three years documented experience.

B. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

1.05 FIELD CONDITIONS

A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Refer to drawings for basis of design products.

2.02 MATERIALS

A. Tile Carpeting: Textured Patterned Loop, manufactured in one color dye lot.
   1. Tile Size: As scheduled.
   2. Color: As indicated on drawings.
   3. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
   4. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").

2.03 ACCESSORIES

A. Edge Strips: Embossed aluminum or rubber, color as selected by Architect.

B. Adhesives:

C. Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.

B. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.

C. Cementitious Subfloor Surfaces: Verify that substrates are ready for flooring installation by testing for moisture and alkalinity (pH).
   1. Test in accordance with Section 09 05 61.
   2. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.
   3. Follow moisture and alkalinity remediation procedures in Section 09 05 61.

D. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

A. Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.

B. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

3.03 INSTALLATION

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install carpet tile in accordance with manufacturer's instructions.

C. Blend carpet from different cartons to ensure minimal variation in color match.

D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.

E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.

F. Locate change of color or pattern between rooms under door centerline.

G. Trim carpet tile neatly at walls and around interruptions.

H. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

A. Remove excess adhesive without damage, from floor, base, and wall surfaces.

B. Clean and vacuum carpet surfaces.

END OF SECTION

SECTION 09 91 13
EXTERIOR PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.

B. Field application of paints.

C. Scope: Finish exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
   1. Exposed surfaces of steel lintels and ledge angles.
   2. Mechanical and Electrical:
      a. On the roof and outdoors, paint equipment exposed to weather or to view, including factory-finished materials where indicated.

D. Do Not Paint or Finish the Following Items:
   1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
   2. Items indicated to receive other finishes.
   3. Items indicated to remain unfinished.
   4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
   5. Non-metallic roofing and flashing.
   6. Stainless steel, anodized aluminum, bronze, terne-coated stainless steel, zinc, and lead.
   7. Marble, granite, slate, and other natural stones.
   8. Floors, unless specifically indicated.
   9. Glass.
   10. Concrete masonry units in utility, mechanical, and electrical spaces.
   11. Concealed pipes, ducts, and conduits.

1.02 REFERENCE STANDARDS

A. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating.

B. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials.

C. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual.

1.03 SUBMITTALS

A. Product Data: Provide complete list of products to be used, with the following information for each:
   1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
   2. MPI product number (e.g. MPI #47).
   3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.

B. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
   1. Where sheen is specified, submit samples in only that sheen.

C. Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, product technical data sheets, material safety data sheets (MSDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Extra Paint and Finish Materials: 1 gallon of each color; from the same product run, store where directed.
2. Label each container with color in addition to the manufacturer's label.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum three years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.06 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the paint product manufacturer's temperature ranges.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Do not apply exterior paint and finishes during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.

D. Minimum Application Temperatures for Latex Paints: 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.

E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide paints and finishes from the same manufacturer to the greatest extent possible.
1. If a single manufacturer cannot provide specified products, minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for substitutions.
2. Substitution of other products by the same manufacturer is preferred over substitution of products by a different manufacturer.

B. Paints:
1. Benjamin Moore: www.benjaminmoore.com/
2. PPG Paints: www.ppgpaints.com/#sle.
3. Sherwin-Williams Company: www.sherwin-williams.com/#sle.

C. Primer Sealers: Same manufacturer as top coats.

D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PAINTS AND FINISHES - GENERAL

A. Paints and Finishes: Ready-mixed, unless required to be a field-catalyzed paint.
1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
2. Supply each paint material in quantity required to complete entire project's work from a single production run.
3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is described explicitly in manufacturer's product instructions.

B. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

C. Colors: To be selected from manufacturer's full range of available colors.
   1. Selection to be made by Architect after award of contract.
   2. Allow for minimum of three colors for each system, unless otherwise indicated, without additional cost to Owner.
   3. Extend colors to surface edges; colors may change at any edge as directed by Architect.

2.03 PAINT SYSTEMS - EXTERIOR

A. Exterior Surfaces to be Painted, Unless Otherwise Indicated: Including concrete, concrete masonry units, brick, fiber cement siding, primed wood, and primed metal.
   1. Two top coats and one coat primer.
   2. Top Coat(s): Exterior Latex.
   3. Top Coat(s): Exterior Alkyd Enamel.
   4. Top Coat Sheen: Verify with Architect prior to application.
      a. Semi-Gloss: MPI gloss level 5.

2.04 PRIMERS

A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.

2.05 ACCESSORY MATERIALS

A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin application of paints and finishes until substrates have been properly prepared.

B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

D. Test shop-applied primer for compatibility with subsequent cover materials.

E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
   1. Fiber Cement Siding: 12 percent.
   2. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
   3. Exterior Wood: 15 percent, measured in accordance with ASTM D4442.

3.02 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces for finishing.

D. Seal surfaces that might cause bleed through or staining of topcoat.

E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

F. Concrete:

1. Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
2. Clean surfaces with pressurized water. Use pressure range of 1,500 to 4,000 psi at 6 to 12 inches. Allow to dry.
3. Clean concrete according to ASTM D4258. Allow to dry.

G. Masonry:
1. Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions. Allow to dry.
2. Prepare surface as recommended by top coat manufacturer.
3. Clean surfaces with pressurized water. Use pressure range of 600 to 1,500 psi at 6 to 12 inches. Allow to dry.

H. Fiber Cement Siding: Remove dirt, dust and other foreign matter with a stiff fiber brush. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

I. Exterior Wood Surfaces to Receive Opaque Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior calking compound after prime coat has been applied. Back prime concealed surfaces before installation.

J. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

B. Exterior Wood to Receive Opaque Finish: If final painting must be delayed more than 2 weeks after installation of woodwork, apply primer within 2 weeks and final coating within 4 weeks.

C. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".

D. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

E. Apply each coat to uniform appearance.

F. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

G. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.05 PROTECTION

A. Protect finishes until completion of project.

B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION

SECTION 09 91 23
INTERIOR PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.

B. Field application of paints.

C. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.

D. Do Not Paint or Finish the Following Items:
   1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
   2. Items indicated to receive other finishes.
   3. Items indicated to remain unfinished.
   4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
   5. Stainless steel, anodized aluminum, bronze, terne-coated stainless steel, and lead items.
   6. Marble, granite, slate, and other natural stones.
   7. Floors, unless specifically indicated.
   8. Ceramic and other tiles.
   9. Brick, architectural concrete, cast stone, integrally colored plaster, and stucco.
   10. Glass.
   11. Concrete masonry units in utility, mechanical, and electrical spaces.
   12. Acoustical materials, unless specifically indicated.
   13. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

A. Section 05 50 00 - Metal Fabrications: Shop-primed items.

B. Section 05 51 00 - Metal Stairs: Shop-primed items.

C. Section 09 91 13 - Exterior Painting.

1.03 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency.

B. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials.

C. CARB (SCM) - Suggested Control Measure for Architectural Coatings; California Air Resources Board.

D. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual.

E. SCAQMD 1113 - Architectural Coatings.

F. SSPC-SP 1 - Solvent Cleaning.

G. SSPC-SP 6/NACE No.3 - Commercial Blast Cleaning.

1.04 SUBMITTALS

A. Product Data: Provide complete list of products to be used, with the following information for each:
   1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
   2. MPI product number (e.g., MPI #47).

3. Cross-reference to specified paint system products to be used in project; include description of each system.
4. Manufacturer's installation instructions.

B. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
1. Where sheen is specified, submit samples in only that sheen.
2. Where sheen is not specified, submit each color in each sheen available.

C. Manufacturer's Instructions: Indicate special surface preparation procedures.

D. Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, product technical data sheets, material safety data sheets (MSDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. Extra Paint and Finish Materials: 1 gal of each color; from the same product run, store where directed.
2. Label each container with color in addition to the manufacturer's label.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum three years documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum three years experience and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.07 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Provide lighting level of 80 fc measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide paints and finishes from the same manufacturer to the greatest extent possible.
1. If a single manufacturer cannot provide specified products; minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for substitutions.
2. Substitution of other products by the same manufacturer is preferred over substitution of products by a different manufacturer.

B. Paints:
1. Benjamin Moore: www.benjaminmoore.com/
2. Pittsburgh Paints: www.pittsburghpaints.com/#sle.
3. Sherwin-Williams Company: www.sherwin-williams.com/#sle.

C. Primer Sealers: Same manufacturer as top coats.

D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PAINTS AND FINISHES - GENERAL

A. Paints and Finishes: Ready-mixed, unless intended to be a field-catalyzed paint.
   1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
   2. Supply each paint material in quantity required to complete entire project's work from a single production run.
   3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.

B. Volatile Organic Compound (VOC) Content:
   1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
      a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
      b. SCAQMD 1113 Rule.
      c. CARB (SCM).
   2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

C. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

2.03 PAINT SYSTEMS - INTERIOR

A. Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, concrete, concrete masonry units, brick, wood, plaster, uncoated steel, shop primed steel, galvanized steel, aluminum, and acoustical ceilings.
   1. Two top coats and one coat primer.
   2. Top Coat(s): Institutional Low Odor/VOC Interior Latex.
   3. Top Coat Sheen: Verify with Architect
      a. Interior Walls: Eggshell
      b. Interior Trim: Semi-gloss
      c. Metal Trim: Semi-gloss

B. Medium Duty Vertical and Overhead: Including gypsum board, plaster, concrete, concrete masonry units, uncoated steel, shop primed steel, galvanized steel, and aluminum.
   1. Two top coats and one coat primer.
   2. Top Coat(s): Institutional Low Odor/VOC Interior Latex; MPI #143, 144, 145, 146, 147, or 148.
   3. Top Coat Sheen: Verify with Architect
      a. Interior Walls: Eggshell.
      b. Interior Trim: Semi-gloss.
      c. Metal Trim: Semi-gloss.

C. Dry Fall: Metals; exposed structure and overhead-mounted services in utilitarian spaces, including shop primed steel deck, structural steel, metal fabrications, galvanized ducts, galvanized conduit, and galvanized piping.
   1. Shop primer by others.
   2. One top coat.
   3. Top Coat: Latex Dry Fall; MPI #118, 155, or 226.

2.04 PRIMERS

A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.

2.05 ACCESSORY MATERIALS

A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

C. Test shop-applied primer for compatibility with subsequent cover materials.

D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
   1. Gypsum Wallboard: 12 percent.
   2. Plaster and Stucco: 12 percent.
   3. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
   4. Interior Wood: 15 percent, measured in accordance with ASTM D4442.

3.02 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.

D. Seal surfaces that might cause bleed through or staining of topcoat.

E. Concrete:
   1. Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
   2. Clean surfaces with pressurized water. Use pressure range of 1,500 to 4,000 psi at 6 to 12 inches. Allow to dry.

F. Masonry:
   1. Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions. Allow to dry.
   2. Prepare surface as recommended by top coat manufacturer.
   3. Clean surfaces with pressurized water. Use pressure range of 600 to 1,500 psi at 6 to 12 inches. Allow to dry.

G. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.

H. Plaster: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high-alkali surfaces.

I. Aluminum: Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.

J. Galvanized Surfaces:

K. Ferrous Metal:
   1. Solvent clean according to SSPC-SP 1.
   2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
   3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning in accordance with SSPC-SP 6/NACE No.3. Protect from corrosion until coated.

L. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.

3.03 APPLICATION

A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".

B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

C. Apply each coat to uniform appearance in thicknesses specified by manufacturer.

D. Sand wood and metal surfaces lightly between coats to achieve required finish.

E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

F. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.05 PROTECTION

A. Protect finishes until completion of project.

B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION

SECTION 10 21 13.16
PLASTIC-LAMINATE-CLAD TOILET COMPARTMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Plastic laminate toilet compartments.

B. Urinal screens.

1.02 REFERENCE STANDARDS

A. ANSI A208.1 - American National Standard for Particleboard.

B. NEMA LD 3 - High-Pressure Decorative Laminates.

1.03 ADMINISTRATIVE REQUIREMENTS

1.04 SUBMITTALS

A. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.

B. Product Data: Provide data on panel construction, hardware, and accessories.

C. Samples: Submit two samples of partition panels, 6 by 6 inches in size illustrating panel finish, color, and sheen.

D. Manufacturer's Installation Instructions: Indicate special procedures.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Plastic Laminate Toilet Compartments:
   1. ASI Accurate Partitions: www.asi-accuratepartitions.com/#sle.
   2. Basis of Design: Bobrick MetroSeries
   3. General Partitions Mfg. Corp: www.generalpartitions.com/#sle.

2.02 MATERIALS

A. Particleboard for Core: ANSI A208.1 composed of wood chips, sawdust or flakes, made with waterproof resin binder; of grade to suit application; sanded faces.

B. Plastic Laminate: NEMA LD 3, HGS.

C. Adhesive: Contact type.

2.03 COMPONENTS

A. Toilet Compartments: Plastic laminate finished, floor-mounted headrail-braced.

B. Doors, Panels, and Pilasters: Plastic laminate adhesive and pressure bonded to faces and edges of particleboard core, with beveled corners and edges; edges of cut-outs sealed.

C. Door and Panel Dimensions:
   1. Thickness: 1 inch.
   2. Door Width: As indicated on drawings.
   3. Door Width for Handicapped Use: 36 inches, outswinging.
   4. Height: 58 inches.

D. Urinal Screens: Wall mounted with two panel brackets, and floor-to-ceiling vertical upright consisting of tubular headrail stock and sockets anchored to floor and ceiling.

2.04 ACCESSORIES

A. Pilaster Shoes: Formed chromed steel with polished finish, 3 inches high, concealing floor fastenings.

1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.

B. Head Rails: Hollow chrome plated steel tube, 1 x 1-5/8 inch size, with anti-grip strips and cast socket wall brackets.

C. Wall and Pilaster Brackets: Polished stainless steel.

D. Attachments, Screws, and Bolts: Stainless steel , tamper proof type.
1. For attaching panels and pilasters to brackets: Through-bolts and nuts ; tamper proof.

E. Hardware: Satin stainless steel:
1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
2. Thumb turn door latch with exterior emergency access feature.
3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
4. Coat hook with rubber bumper; one per compartment, mounted on door.
5. Provide door pull for outswinging doors.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated on drawings.

B. Verify correct spacing of and between plumbing fixtures.

3.02 INSTALLATION

A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.

B. Maintain 3/8 to 1/2 inch space between wall and panels and between wall and end pilasters.

C. Attach panel brackets securely to walls using anchor devices.

D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.

3.03 TOLERANCES

3.04 ADJUSTING

A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.

B. Adjust hinges to position doors in partial opening position when unlatched. Return out-swinging doors to closed position.

C. Adjust adjacent components for consistency of line or plane.

END OF SECTION

SECTION 10 28 00
TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Commercial toilet accessories.

B. Diaper changing stations.

1.02 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design.

B. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

C. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

D. ASTM B456 - Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.

E. ASTM C1036 - Standard Specification for Flat Glass.

F. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror.

G. ASTM F2285 - Standard Consumer Safety Performance Specification for Diaper Changing Tables for Commercial Use.

H. NFPA 70 - National Electrical Code.

I. TAS - Texas Accessibility Standards.

J. UL (ECMD) - Electrical Construction Materials Directory.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.04 SUBMITTALS

A. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.

B. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Refer to drawings for basis of design products.

B. Commercial Toilet, Shower, and Bath Accessories:
   1. American Specialties, Inc: www.americanspecialties.com/#sle.
   2. Bobrick Washroom Equipment, Inc; www.bobrick.com
   3. Bradley Corporation: www.bradleycorp.com/#sle.

C. Diaper Changing Stations:
   1. American Specialties, Inc: www.americanspecialties.com/#sle.
   2. Bradley Corporation: www.bradleycorp.com/#sle.
   3. Koala Kare Products: www.koalabear.com/#sle.

2.02 PERFORMANCE CRITERIA

A. The structural strength of grab bars, tub and shower seats, fasteners, and mounting devices shall meet the following specifications:

1. Shear force induced in a fastener or mounting device from the application of 250 lbf shall be less than the allowable lateral load of either the fastener or mounting device or the supporting structure, whichever is the smaller allowable load.
2. Tensile force induced in a fastener by a direct tension force of 250 lbf plus the maximum moment from the application of 250 lbf shall be less than the allowable withdrawal load between the fastener and the supporting structure.

B. Products Requiring Electrical Connection: Listed and classified by UL (ECMD) as suitable for the purpose specified and indicated.

C. Perform electrical work in accordance with NFPA 70.

2.03 MATERIALS

A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
1. Grind welded joints smooth.
2. Fabricate units made of metal sheet of seamless sheets with flat surfaces.

B. Keys: Provide two keys for each accessory to Owner; master key lockable accessories.

C. Stainless Steel Sheet: ASTM A666/A666M, Type 304.

D. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.

E. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.

F. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

2.04 FINISHES

A. Stainless Steel: Satin finish, unless otherwise noted.

B. Chrome/Nickel Plating: ASTM B456, SC 2, polished finish, unless otherwise noted.

C. Shop Primed Ferrous Metals: Pretreat and clean, spray apply one coat primer and bake.

2.05 COMMERCIAL TOILET ACCESSORIES

A. Refer to drawings for basis of design products.

B. Toilet Paper Dispenser: Multi- roll, surface mounted, stainless steel.

C. Combination Towel Dispenser/Waste Receptacle: Surface-mounted with projecting waste receptacle, stainless steel; seamless wall flanges, continuous piano hinges.

D. Automated Soap Dispenser: Liquid soap dispenser, wall-mounted, with low level indicator.
1. Minimum Capacity: 40 ounces.

E. Seat Cover Dispenser: Stainless steel, surface-mounted, reloading by concealed opening at base, tumbler lock.
1. Minimum capacity: 250 seat covers.

F. Grab Bars: Stainless steel, peened surface.
1. Standard Duty Grab Bars:
a. Push/Pull Point Load: 250 pound-force, minimum.
b. Dimensions: 1-1/4 inch outside diameter, minimum 0.05 inch wall thickness, exposed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
c. Finish: Satin.
d. Length and Configuration: As indicated on drawings.

G. Sanitary Napkin Disposal Unit: Stainless steel, surface-mounted, self-closing door, locking bottom panel with full-length stainless steel piano-type hinge, removable receptacle.

H. Illuminated Mirrors: Frosted glass edgemirrorbacklit LED lighting.
1. Mirror Shape: Rectangle.

2. Mirror Mounting: Surface.

I. Robe Hook: Heavy-duty stainless steel, single-prong, backplate attachment, satin finish.

2.06 DIAPER CHANGING STATIONS

A. Diaper Changing Station: Wall-mounted folding diaper changing station for use in commercial toilet facilities, meeting or exceeding ASTM F2285.
1. Material: Stainless steel.
2. Mounting: Surface.
3. Minimum Rated Load: 250 pounds.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify exact location of accessories for installation.

C. For electrically-operated accessories, verify that electrical power connections are ready and in the correct locations.

D. Verify that field measurements are as indicated on drawings.

E. See Section 06 10 00 and 09 21 16 for installation of blocking, reinforcing plates, and concealed anchors in walls.

3.02 PREPARATION

A. Deliver inserts and rough-in frames to site for timely installation.

B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.

B. Install plumb and level, securely and rigidly anchored to substrate.

C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.
1. Comply with TAS and ADA Standards.
2. Grab Bars: As indicated on drawings.

3.04 PROTECTION

A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION

SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire extinguishers.

B. Fire extinguisher cabinets.

1.02 REFERENCE STANDARDS

A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.

B. NFPA 10 - Standard for Portable Fire Extinguishers.

1.03 SUBMITTALS

A. Product Data: Provide extinguisher operational features.

B. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.

C. Manufacturer's Instructions: Indicate special criteria and wall opening coordination requirements.

D. Operation and Maintenance Data: Include test, refill, or recharge schedules and recertification requirements.

1.04 FIELD CONDITIONS

A. Do not install extinguishers when ambient temperature causes freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fire Extinguishers:
1. Activar Construction Products Group, Inc. - JL Industries: www.activarcpg.com/#sle.
2. Kidde, a unit of United Technologies Corp: www.kidde.com/#sle.
3. Nystrom, Inc: www.nystrom.com/#sle
4. Potter-Roemer: www.potterroemer.com/#sle.

B. Fire Extinguisher Cabinets and Accessories:
1. Activar Construction Products Group, Inc. - JL Industries: www.activarcpg.com/#sle.
2. Kidde, a unit of United Technologies Corp: www.kidde.com/#sle.
3. Larsen's Manufacturing Co: www.larsensmfg.com/#sle.
4. Nystrom, Inc: www.nystrom.com/#sle
5. Potter-Roemer: www.potterroemer.com/#sle.

2.02 FIRE EXTINGUISHERS

A. General Requirements: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.

B. Multipurpose Dry-Chemical-Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
1. Class: A:B:C.
2. Size: 10 pound.
3. Finish: Baked polyester powder coat, red color.
4. Temperature range: Minus 40 degrees F to 120 degrees F.

2.03 FIRE EXTINGUISHER CABINETS

A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire-resistance rating of walls where cabinet installed.

B. Fire Rated Cabinet Construction: Not less than adjacent construction.

1. Steel; double wall or outer and inner boxes with 5/8-inch thick fire barrier material.

C. Cabinet Configuration: Semi-recessed type.
1. Size to accommodate accessories.
2. Trim: Flat rolled edge, with 2 inch wide face.
3. Provide cabinet enclosure with right angle inside corners and seams, and with formed perimeter trim.

D. Door: 0.036 inch metal thickness, reinforced for flatness and rigidity lockable with recessed pulls. Hinge doors for 180 degree opening with continuous piano hinge.

E. Door Glazing: Float glass, clear, 1/8 inch thick, and set in resilient channel glazing gasket.

F. Cabinet Mounting Hardware: Appropriate to cabinet, with predrilled holes for placement of anchors.

G. Fabrication: Weld, fill, and grind components smooth.

H. Finish of Cabinet Exterior Trim and Door: Baked enamel, white color.

I. Finish of Cabinet Interior: White colored enamel.

2.04 ACCESSORIES

A. Extinguisher Brackets: Formed steel, chrome-plated.

B. Lettering: FIRE EXTINGUISHER text on decal or self-adhesive vinyl, prespaced black lettering in accordance with authorities having jurisdiction.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and interfaces with other work.

B. Verify substrate and site conditions for product installation are in accordance with manufacturer's written instructions.

C. Notify Architect in writing of conditions detrimental to completion of work. Do not proceed with installation until detrimental conditions are corrected.

D. Verify rough openings for cabinet are sized and located in accordance with manufacturer's written instructions.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install cabinets plumb and level in wall openings, not more than 48 inches from finished floor to inside bottom of cabinet.

C. Secure rigidly in place.

D. Place extinguishers and accessories in cabinets.

END OF SECTION

SECTION 10 73 26
WALKWAY COVERINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pre-engineered, pre-finished extruded metal walkway coverings.

1.02 REFERENCE STANDARDS

A. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).

B. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).

C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.

D. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).

G. ASTM D523 - Standard Test Method for Specular Gloss.

H. ASTM D2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.

I. ASTM D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.

1.03 SUBMITTALS

A. Metal Product Data: Product data sheets, including material descriptions and finishes, and preparation instructions and recommendations.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, footings, anchorage, size and type of fasteners, deck panels, cross sections, and trim details clearly indicating proper assembly.

C. Samples, Metal Components: Two samples, minimum size 2 by 3 inches, representing actual material and finish of exposed metal.

D. Design Data: Submit comprehensive structural analysis of design for the specified loads. Stamp and sign calculations by professional engineer.

E. Manufacturer's Instructions:
   1. Storage and handling requirements and recommendations.
   2. Preparation instructions and recommendations.
   3. Installation methods.

F. Designer's qualification statement.

G. Manufacturer's qualification statement.

H. Installer's qualification statement.

I. Executed warranty.

J. Specimen warranty.

1.04 QUALITY ASSURANCE

A. Designer Qualifications: Perform design under direct supervision of Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.05 WARRANTY

A. Finish Warranty: Provide 20-year manufacturer warranty against excessive degradation of factory-applied finishes. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.
   1. Chalking: No more than that represented by a No.8 rating based on ASTM D4214.
   2. Color Retention: No fading or color change in excess of 5 Hunter color difference units, calculated in accordance with ASTM D2244.
   3. Gloss Retention: Minimum of 30 percent gloss retention, when tested in accordance with ASTM D523.

B. Correct defective Work within a two year period after Substantial Completion, including defects in water tightness and integrity of seals.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide all walkway coverings from a single manufacturer.

B. Metal Walkway Coverings and Sun Shades:
   1. AVAdek Walkway Covers & Canopies: www.avadek.com/#sle.
   2. C.R.Laurence Co., Inc.: www.crlaurence.com
   3. East Texas Canopy, Inc.: www.easttexascanopy.com

2.02 DESCRIPTION

A. Design Criteria: Design and fabricate to resist the following loads without failure, damage, or permanent deflection in accordance with ASCE 7.
   1. Loads: As indicated on drawings.
   2. Thermal Movement: Plus/minus 1/8 inch, maximum.

B. Canopy Configuration: Column layout, walkway clearance, fascia profile, and roof covering design as indicated on drawings.
   1. Decking Orientation: As indicated on drawings.

C. Aluminum Sun Shades: Shop fabricated, shop finished, extruded aluminum outriggers, louvers, and fascia, free of defects impairing strength, durability or appearance.
   1. Outrigger Shape: As indicated on drawings.

D. Provide a complete system ready for erection at project site.

E. Shop fabricate to the greatest extent possible; disassemble if necessary for shipping.

2.03 METAL WALKWAY COVERINGS AND SUNSHADES

A. Protective Covers: Pre-engineered, pre-finished extruded aluminum frame assembly, interlocking deck sections secured with screws, and fascia.
   1. Structural Performance: Capable of withstanding design loads specified by applicable building code .
   2. Drainage: Self-draining from deck through bents to discharge point at ground level or as otherwise shown.

B. Type: Attached to structure, as indicated on drawings.

C. Beams: Open top aluminum tubular extrusions of size as required by structural engineering design.

D. Columns: Extruded aluminum, designed for concealed drainage from beams to deck level.

E. Column Anchorage: Column baseplates installed with anchor bolts or expansion anchors into concrete footing, slab, or pier.

F. Framework: Aluminum.

G. Water Management: Drain beams and internal column drains with drainage outlet on grade.

H. Deck: Rigid-Roll-Lock extruded aluminum, self-flashing, interlocking sections of size and profile as required by structural engineering design.
   1. Provide welded end plate water dams where sections terminate at other than drainage channels.
   2. Finish: Fluoropolymer coating.
   3. Color: As selected by architect from manufacturer's standard color range.

I. Covering Materials:
   1. Interlocking extruded aluminum decking modules.

J. Fascia: Manufacturer's standard extruded aluminum fascia sections as shown on drawings.
   1. Finish: Fluoropolymer coating.
   2. Color: Custom color as selected by architect.

K. Hanger Rods: 3/4 inch diameter rods and attachment hardware, hot-dip galvanized.

L. Wall Brackets: Fabricated from stainless steel or aluminum and designed to receive and anchor the hanger rods to the substructure.

2.04 COMPONENTS

A. Aluminum Framing:
   1. Columns: Extruded aluminum.
      a. Cross-Section: As indicated on drawings.
   2. Beams: Extruded aluminum.
   3. Decking: Self-flashing, interlocking sections.
   4. Fascia Extruded aluminum.

B. Exposed Framing Fasteners: Flush countersunk stainless steel screws or bolts; consistent with design of system and acceptable to manufacturer.
   1. Decking Fasteners: Stainless steel with neoprene washers.
   2. Finish exposed fasteners to match metal frame.

C. Flashings: Metal and finish matching system framing components, with thickness as recommended by manufacturer for conditions encountered.

2.05 MATERIALS

A. Aluminum:
   1. Aluminum Extrusions: Alloy and temper 6063-T5, 6063-T6, or 6061-T6 members complying with ASTM B221 (ASTM B221M), with minimum thickness 1/8 inch for structural members and 1/16 inch for nonstructural members.
   2. Formed Aluminum: Sheet material of alloy 5052, 5005, or 6061-T651 members complying with ASTM B209/B209M, with minimum thickness 1/8 inch for structural members and 1/16 inch for nonstructural members.

2.06 FABRICATION - METAL COMPONENTS

A. Fit and shop assemble components in largest practical sizes, for delivery to site.

B. Fabricate components with joints tightly fitted and secured.

C. Exposed Fastenings: Unobtrusively located; consistent with design of component, except where specifically noted otherwise.

D. Supply components required for anchorage of framing. Fabricate anchors and related components of same material and finish as framing, except where specifically noted otherwise.

E. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

F. Accurately form components to suit each other and to building structure.

2.07 FINISHES

A. Superior Performing Organic Coatings: AAMA 2605, multiple coats, thermally cured polyvinylidene fluoride system.

B. Pigmented Organic Coatings: AAMA 2603, polyester or acrylic baked enamel finish.

C. Finish Color: As selected by Architect to match sample.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and site area for conditions that might prevent satisfactory installation.

B. Examine footings in which bents will be set. Verify footing locations and elevations comply with shop drawings.

C. Verify that foundation, electrical utilities, and placed anchors are in correct position.

D. Verify that bearing surfaces are ready to receive this work.

E. Do not proceed with installation until conditions are satisfactory.

3.02 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

B. Supply items required to be cast into concrete with setting templates for installation of work in other sections.

3.03 INSTALLATION - FRAMING

A. Install in accordance with manufacturer's instructions.

B. Install components plumb and level, accurately fitted, free from distortion or defects.

C. Provide anchors required for connecting framing to structure. Anchor framing to structure.

D. Field weld anchors as indicated on drawings. Grind welds smooth. Touch-up welds with primer.

E. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

F. Keep aluminum surfaces from direct contact with ferrous metal or other incompatible materials by applying one coat of zinc chromate primer; follow with two coats of aluminum paint.
   1. In lieu of aluminum paint, one coat of high-build bituminous paint applied to 1/16 inch thickness may be used.

3.04 INSTALLATION - METAL COVERING

A. Install in accordance with manufacturer's instructions.

B. Fasten metal decking to metal support members, aligned level and plumb.

C. Install fascia panels, trim, and flashing.

D. Separate dissimilar metals using concealed bituminous paint.

E. Touch-up damaged finish coating using material provided by manufacturer to match original coating.

3.05 TOLERANCES

A. Maximum Variation from Plumb, Level, or Line: 1/8 inch per 10 feet, or 3/8 inch total in overall dimension.

B. Alignment of Two Adjoining Members Abutting in Plane: Within 1/16 inches.

3.06 FIELD QUALITY CONTROL

A. Test for watertightness, water management, and lack of ponding of completed walkway covering and components, including decking, drain beams, and columns.

3.07 CLEANING

A. Remove surplus materials and debris from the site.

B. Clean all exposed surfaces after installation.

3.08 PROTECTION

A. Touch-up, repair, or replace damaged components before Date of Substantial Completion.

B. Protect walkway covering after installation to prevent damage due to other work until Date of Substantial Completion.

END OF SECTION

SECTION 12 21 13
HORIZONTAL LOUVER BLINDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Horizontal slat louver blinds.

B. Operating hardware.

1.02 REFERENCE STANDARDS

A. WCMA A100.1 - Standard for Safety of Window Covering Products.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the placement of concealed blocking to support blinds. See Section 06 10 00.

1.04 SUBMITTALS

A. Product Data: Provide data indicating physical and dimensional characteristics.

B. Shop Drawings: Indicate opening sizes, tolerances required, method of attachment, clearances, and operation.

C. Samples: Submit two samples, 6 inch long illustrating slat materials and finish, cord type and color.

D. Manufacturer's Installation Instructions: Indicate special procedures.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

2.02 BLINDS WITHOUT SIDE GUIDES

A. Description: Horizontal slat louvers hung from full-width headrail with full-width bottom rail.

B. Manual Operation: Control of raising and lowering by cord with full range locking; blade angle adjustable by control wand.

C. Metal Slats: Spring tempered pre-finished aluminum; square slat corners, with manufacturing burrs removed.
   1. Width: 1 inch.
   2. Color: As selected by Architect.

D. Slat Support: Woven polypropylene cord, ladder configuration.

E. Head Rail: Pre-finished, formed aluminum box, with end caps; internally fitted with hardware, pulleys, and bearings for operation; same depth as width of slats.
   1. Color: Same as slats.

F. Bottom Rail: Pre-finished, formed aluminum; with end caps.
   1. Color: Same as headrail.

G. Control Wand: Extruded solid plastic; hexagonal shape.
   1. Non-removable type.
   2. Length of window opening height less 3 inch.
   3. Color: Clear.

H. Headrail Attachment: Wall brackets.

I. Accessory Hardware: Type recommended by blind manufacturer.

2.03 FABRICATION

A. Determine sizes by field measurement.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that openings are ready to receive the work.

B. Ensure structural blocking and supports are correctly placed. See Section 06 10 00.

3.02 INSTALLATION

A. Install blinds in accordance with manufacturer's instructions.

B. Secure in place with flush countersunk fasteners.

3.03 TOLERANCES

A. Maximum Variation of Gap at Window Opening Perimeter: 1/4 inch.

B. Maximum Offset From Level: 1/8 inch.

3.04 ADJUSTING

A. Adjust blinds for smooth operation.

3.05 CLEANING

A. Clean blind surfaces just prior to occupancy.

END OF SECTION

SECTION 12 36 00
COUNTERTOPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Countertops for architectural cabinet work.

B. Wall-hung counters and vanity tops.

1.02 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition.

C. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards.

D. ISFA 2-01 - Classification and Standards for Solid Surfacing Material.

E. NEMA LD 3 - High-Pressure Decorative Laminates.

1.03 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Specimen warranty.

B. Shop Drawings: Complete details of materials and installation ; combine with shop drawings of cabinets and casework specified in other sections.

C. Verification Samples: For each finish product specified, minimum size 6 inches square, representing actual product, color, and patterns.

D. Test Reports: Chemical resistance testing, showing compliance with specified requirements.

E. Certificate: Submit labels and certificates required by quality assurance and quality control programs.

F. Installation Instructions: Manufacturer's installation instructions and recommendations.

G. Maintenance Data: Manufacturer's instructions and recommendations for maintenance and repair of countertop surfaces.

1.04 QUALITY ASSURANCE

A. Quality Certification:
   1. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) requirements for grade or grades specified.
   2. Provide designated labels on shop drawings as required by certification program.
   3. Provide designated labels on installed products as required by certification program.
   4. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.06 FIELD CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.07 WARRANTY

A. Provide ten year manufacturer warranty for solid surfacing material.

PART 2 PRODUCTS

2.01 COUNTERTOPS

A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.

B. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
   1. Flat Sheet Thickness: 1/2 inch, minimum.
   2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
      a. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
      b. NSF approved for food contact.
      c. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
   3. Other Components Thickness: 1/2 inch, minimum.
   4. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.

2.02 MATERIALS

A. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.

B. Joint Sealant: Mildew-resistant silicone sealant, white.

C. Solvent: Product recommended by manufacturer to clean surfacing materials to assure adhesion of adhesives, fillers and sealants.

D. Cleaning Agents: Non-abrasive, soft-scrub type kitchen cleansers.

2.03 ACCESSORIES

A. Countertop Wall Brackets, Concealed: Minimum 0.25 inch thick steel, formed 2 inch wide flanges with pre-punched 0.39 inch square mounting holes; without upper extension; black textured powder coating finish; including mounting bolts, nuts, and washers.
   1. Size: To suit application.
   2. Manufacturer:
      a. A & M Hardware, Inc.; www.AandMhardware.com.
      b. Richelieu: Triade concealed bracket; www.richelieu.com
      c. U.S. Futaba, Inc.: www.usfutaba.com.

2.04 FABRICATION

A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
   1. Join lengths of tops using best method recommended by manufacturer.
   2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
   3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.

B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
   1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
   2. Height: 4 inches, unless otherwise indicated.

C. Solid Surfacing: Fabricate tops and wall panels up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.

D. Wall-Mounted Counters: Provide skirts, aprons, brackets, and braces as indicated on drawings, finished to match.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

A. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.

B. Install solid surfacing materials with mounting adhesive in accordance with adhesive manufacturer's recommendations.
   1. Joint Treatment Between Adjacent Pieces:
      a. Set joints flush, tight fitting, level and neat.
      b. Tool joint filler into joints according to manufacturer's printed instructions. Tool filler surface to flush profile.

C. Seal joint between back/end splashes and vertical surfaces.

3.04 TOLERANCES

A. Variation From Horizontal: 1/8 inch in 10 feet, maximum.

B. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.

C. Field Joints: 1/8 inch wide, maximum.

3.05 CLEANING

A. Clean countertops surfaces thoroughly.

3.06 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 210000
GENERAL REQUIREMENTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Basic Fire Protection Requirements specifically applicable to Division 21 sections, in addition to Division 01 - General Requirements.

1.02 RELATED DOCUMENTS

A. Basic and supplemental requirements common to Fire Protection.

B. THE UNIFORM GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, and Division 01 of the specifications apply to the work specified in this section.

C. All work covered by this section of these specifications shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.

1.03 GENERAL

A. The Contractor shall execute all work herein after specified or indicated on accompanying drawings. Contractor shall provide all equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the Drawings.

B. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation

C. The Fire Protection Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe in its exact location. These details are subject to the requirements of standards referenced elsewhere in these specifications, and structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases, above suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed or where no ceilings exist. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted. All work shall be NFPA compliant and compliant with Insurance Underwriter requirements and guidelines.

D. When the Fire Protection drawings do not give exact details as to the elevation of pipe the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping is generally intended to be installed true and square to the building construction, The Drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas, unless there is no ceiling.

1.04 DEFINITIONS

A. These definitions are included to clarify the direction and intention of these Specifications. The list given here is not by any means complete. For further clarification as required, contractor shall contact the designated Owner's representative.

1. Concealed / Exposed: Concealed areas are those that cannot be seen by the building occupants. Exposed areas are all areas that are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms.

2. General Requirements: The provisions of requirements of other Division 01 sections apply to entire work of contract and, where so indicated, to other elements that are included in project. Basic contract definitions are included in the General Conditions.
3. Indicated: The term "indicated" is a cross reference to graphic representations, notes or schedules on drawings, to other paragraphs or schedules in the specifications, and to similar means of recording requirements on contract documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used in lieu of "indicated," it is for the purpose of helping reader locate the cross reference, and no limitation of location is intended except as specifically noted.
4. Directed, requested, etc.: Where not otherwise explained, terms such as "directed," "requested," "authorized," "selected," "approved," "required," "accepted," and "permitted" mean "directed by Architect/Engineer," "requested by Architect/Engineer" and similar phrases. However, no such implied meaning will be interpreted to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.
5. Approve: Where used in conjunction with Architect's/Engineer's response to submittals, requests, applications, inquiries, reports and claims by Contractor, the meaning of term "approved" will be held to limitations to Architect's/Engineer's responsibilities and duties as specified in General and Supplementary Conditions. In no case will "approval" by Architect/Engineer be interpreted as a release of Contractor from responsibilities to fulfill requirements of contract documents or to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.
6. As required: Where "as required" is used in these specifications or on the drawings, it shall mean "that situations exist that are not necessarily described in detail or indicated that may cause the contractor certain complications in performing the work described or indicated. These complications entail the normal coordination activities expected of the Contractor where multiple trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result."
7. Furnish: The term "furnish" is used to mean "supply and deliver to project site, ready for unloading, unpacking, assemble, installation, and similar operations. Where "furnish" applies to work for which the installation is not otherwise specified, "furnish" in such case shall mean "furnish and install."
8. Install: The term "install" is used to describe operations at Project Site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
9. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use.

1.05 REFERENCE STANDARDS

A. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.06 PERMITS, UTLILITY CONNECTIONS AND INSPECTIONS

A. General: Refer to Division 01 for construction phasing and time increments.

B. Fees and Costs: If, during the course of the construction, a need arises to buy utilities, the Contractor shall pay all fees attendant thereto. If city or privately owned utility piping or electrical cable needs to be extended, relocated, or terminated, the Contractor will pay all permits and construction/inspection fees associated with that particular work.

C. All work performed on this project is under the authority of the State of Texas, therefore no local construction fees or construction permits will be required except as may be required for new service taps, or new or modified connections to city controlled services. If inspections by city

personnel are specifically required by this document, then the Contractor is responsible for any fees or permits in connection to those requirements.

D. Compliance: The Contractor shall comply in every respect with all requirements of National Fire Protection Association, local Fire Department regulations and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these specifications and drawings where specified conditions are of higher quality than the requirements of the above-specified authorities. Where requirements of the specifications and drawings are more lenient than the requirements of the above authorities having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities with no extra compensation.

E. Fire hydrant flow test shall be witnessed by a AHJ.

1.07 CONTRACT DRAWINGS

A. All dimensional information related to new structures shall be taken from the appropriate drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.

B. The interrelation of the specifications, the Drawings, and the Schedules are as follows: The Specifications determine the nature and setting of the several materials, the Drawings establish the quantities, dimensions and details, and the Schedules give the performance characteristics. If the Contractor requires additional clarification, he shall request it in writing, following the contractually prescribed information flow requirements.

C. Should the drawings or specifications conflict within themselves, or with each other, the better quality, or greater size or quantity of work or materials shall be performed or furnished.

1.08 ALLOWANCES

A. Cash Allowance: Refer to Division 01 of the Construction Documents for information and requirements.

1.09 SUBMITTALS

A. Refer to Division 01, UGC, and supplemental UGCs for specification requirements pertaining to timeliness of submission and review, quantity, and format. Each specification section describes the content of the submittals and any submittals which must be approved prior to submission of others.

B. Proposed Products List: Include Products specified in the following sections:
   1. Section 21 05 29 – Fire Protection Supports and Sleeves
   2. Section 21 05 53 – Fire Protection Piping and Equipment Identification
   3. Section 21 08 00 – Fire Protection Systems Commissioning
   4. Section 21 10 00 – Water Based Fire Suppression Systems
   5. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories clearly marked and/or highlighted, with non-applicable information or data clearly noted in a single submittal.

C. Mark dimensions and values in units to match those specified.

D. Submit fabrication drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the Drawings, thus causing rearrangement of equipment space, (2) where tight spaces require extreme coordination between ductwork, piping, conduit, and other equipment, (3) where called for elsewhere in these specifications; and (4) where specifically requested by the Architect/Engineer. Fabrication drawings shall be made at no additional charge to the Owner or the Architect/Engineer.

1.10 SUBSTITUTION OF MATERIALS AND EQUIPMENT

A. Refer to General Conditions for substitution of materials and equipment.

B. General: Within thirty days after the date of Contract award or work order, whichever is later, and before purchasing or starting installation of materials or equipment, the Contractor shall submit for review, a complete list of suppliers, contractors and manufacturers for all materials and equipment that will be submitted for incorporation into the project. The list shall be arranged in accordance with the organization of the specifications. This initial list shall include the manufacturer's name and type or catalog number as required to identify the quality of material or equipment proposed. This list will be reviewed by the Engineer and the Owner and will be returned to the Contractor with comments as to which items are acceptable without further submittal data and which items will require detailed submittal data for further review and subsequent approval. The initial list shall be submitted as herein specified. Materials and equipment requiring detailed submittal data shall be submitted with sufficient data to indicate that all requirements of these specifications have been met and samples shall be furnished when requested. All manufacturers' data used as part of the submittal shall have all inapplicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished.

C. It is not the intent of the drawings and/or specifications to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).

D. The specified products have been used in preparing the drawings and specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the Architect/Engineer is final.

E. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

F. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks' time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

G. All equipment installed on this project shall have local representation, local factory authorized service, and a local stock of repair parts.

H. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

I. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the specifications.

J. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

K. Materials and Equipment Lists: Eight (8) copies of the list of materials and equipment, the name of manufacturer, trade name, type, and catalog number shall be submitted to the Architect/Engineer. The lists shall be accompanied by eight (8) sets of pictorial and descriptive data derived from the manufacturers' catalogs, sales literature, or incorporated in the shop drawings.

L. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

1.11 MATERIALS AND WORKMANSHIP

A. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use, and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job site but shall be replaced with new materials and/or equipment.

B. The responsibility for the furnishing of the proper equipment and/or material and seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor who shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

1.12 FLAME SPREAD PROPERTIES OF MATERIALS

A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

1.13 REGULATORY REQUIREMENTS

A. The "Authority Having Jurisdiction" over the project described by these documents is the Owner, as an Agency of the State of Texas. As such, it is required that the installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of these specifications. All referenced codes and standards shall be those current at the date of issue of the design documents.

B. National Fire Protection Association Standards (NFPA)
   1. NFPA No. 13, Sprinkler System, Installation, 2013 edition.
   2. NFPA No. 70, National Electrical Code, 2017 edition.
   3. NFPA No. 72D, Proprietary Signaling Systems, 2013 edition.
   4. NFPA No. 101, Life Safety Code, 2015 edition.
   5. NFPA No. 291, Recommended Practice for Fire Flow Testing and Marking of Hydrants, current edition.

C. American National Standards Institute (ANSI)

D. American Society of Testing Materials (ASTM): All current editions of applicable manuals and standards

E. American Water Works Association (AWWA): All current editions of applicable manuals and standards.

F. National Electrical Manufacturers' Association (NEMA): All current editions of applicable manuals and standards.

G. International Building and Fire Codes, 2021 edition with City of Houston, Texas amendments.

H. City of Houston, Texas Fire Department as may be applicable to construction on this site.

I. Texas Occupational Safety Act: All applicable safety standards.

J. Occupational Safety and Health Act (OSHA).

K. ADA and ANSI Standards: All work shall be in accord with all regulations and requirements of the Standards and Specifications for Handicapped and Disabled for the Construction of Public Buildings and Facilities in the State of Texas Usable by Physically Handicapped and Disabled persons, ANSI Standards and the requirements of the American Disabilities Act.

L. Refer to Specification sections hereinafter bound for additional Codes and Standards.

M. All materials and workmanship shall comply with all applicable state and national codes, specifications, and industry standards. In all cases where Underwriters Laboratories, Inc. has established standards for a particular type material, such material shall comply with these standards. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.

N. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect/Engineer in writing of said discrepancies and apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 01 of these Contract Documents, providing no work of fabrication of materials has been accomplished in a manner of noncompliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations

1.14 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

A. Storage at Site: The Contractor shall not receive material or equipment at the job site until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.

B. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

C. Conformance with Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements. The label of the Underwriters Laboratories, Inc., applied to the item will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.

D. Nameplates: Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

E. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating. The treatment shall withstand 200 hours in salt spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8" on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified except that coal tar or asphalt type coating will not be acceptable unless so stated for a specific item. Where steel is specified

to be hot dip galvanized, mill galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

F. Protection from Moving Parts: Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts shall be fully enclosed or properly guarded for personnel protection.

G. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.

1.15 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other sections. Obtain permission of Owner before proceeding.

1.16 MANUFACTURER'S RECOMMENDATIONS

A. The manufacturer's published directions shall be followed in the delivery, storage, protection, installation, testing and piping of all equipment and material. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflict between the requirements of the Contract Documents and the manufacturer’s directions, and shall obtain the Architect/Engineer's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer’s directions or such instructions from the Architect/Engineer, he shall bear all costs arising in connection with the deficiencies.

1.17 SPACE AND EQUIPMENT ARRANGEMENT

A. The size of Fire Protection equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space. Fabrication drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

B. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

1.18 LARGE APPARATUS

A. Any large piece of apparatus that is to be installed in any space in the building, and that is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly, completely protected from damage as hereinafter specified.

1.19 PROTECTION

A. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture

damage. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.

B. Take particular care not to damage the building structure in performing work. All finished floors, step treads, and finished surfaces shall be covered to prevent any damage by workers or their tools and equipment during the construction of the building.

C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these specifications.

1.20 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS

A. Each trade, subcontractor, and/or Contractor must work in harmony with the various other trades, subcontractors and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

1.21 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

A. The Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings, and should any mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

B. The electrical trades shall provide all interconnecting wiring for the installation of all power. The electrical trades shall provide all disconnect switches as required for proper operation, as indicated on the drawings or required by applicable code. All combination starters, individual starters, and other motor starting apparatus not specifically scheduled or specified as provided by the equipment manufacturer under the scope of Division 23, shall be provided under the scope of Division 21.

C. Provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review within thirty (30) days after the submittals for equipment have been reviewed. Diagrams shall be based on accepted equipment and shall be complete full phase and interlock control drawings, not a series of manufacturer's individual diagrams. After these diagrams have been reviewed by the Architect/Engineer, copies shall be transmitted to the electrical trades by the Contractor.

1.22 SUPERVISION

A. Each Contractor and subcontractor shall keep a competent superintendent or foreman on the job at all times. (Refer to the Uniform General Conditions for additional information concerning supervision.)

B. It shall be the responsibility of each superintendent to study all drawings and familiarize himself with the work to be done by other trades. He shall coordinate his work with other trades and before material is fabricated or installed, make sure that his work will not cause an interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the superintendents involved. Where interferences cannot be resolved without major changes to the drawings, the matter shall be referred to the A/E for ruling.

1.23 SITE OBSERVATION

A. Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Contract Documents, and shall not be construed as construction supervision nor indication of approval of the manner or location in which the work is being performed as being a safe practice or place.

1.24 INSTALLATION METHODS

A. Where to Conceal: All pipes shall be concealed in pipe chases, walls, furred spaces, or above the ceilings of the building unless otherwise indicated.

B. Where to Expose: In mechanical rooms, janitor's closets tight against pan soffits in exposed "Tee" structures, or storage spaces, but only where necessary, piping may be run exposed. All exposed piping shall be run in the most aesthetic, inconspicuous manner, and parallel or perpendicular to the building lines.

C. Support: All piping shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified.

D. Maintaining Clearance: Where limited space is available above the ceilings below concrete beams or other deep projections, pipe shall be sleeved through the projection where it crosses, rather than hung below them in a manner to provide maximum above floor clearance. Sleeves shall be as herein specified. Approval shall be obtained from the Architect/Engineer for each penetration.

E. All pipe shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All pipes run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.
   1. All piping not directly buried in the ground shall be considered as "interior piping."
   2. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the construction inspector so that arrangement can be made for an inspection of the above ceiling area about to be "sealed" off. The Contractor shall give as much advance notice as possible no less than 5 working days or as agreed by the Project Manager.
   3. All above ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. All mechanical and electrical work at and above the ceiling, including items supported by the ceiling grid shall be complete and installed in accordance with contract requirements, including power to other powered items. Adequate lighting shall be provided to permit thorough inspection of all above ceiling items. The inspection will include representatives of the following: General Contractor and each Subcontractor having work above the ceiling, Architect/Engineer and Owner’s Construction Manager. Areas to be included and time of inspection shall be coordinated with the Construction Inspector.
   4. The purpose of this inspection is to verify the completeness and quality of the installation of the air conditioning systems, the electrical systems, the plumbing systems, and any other special above ceiling systems such as pneumatic tube, vacuum systems, fire sprinkler piping and cable tray systems. The ceiling supports (tee bar or lath) shall be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.
   5. No ceiling materials may be installed until the resulting deficiency list from this inspection is worked off and the Construction Inspector has given approval.

1.25 RECORDS FOR OWNER

A. The Contractor shall maintain a set of "blueline" prints in the Field Office for the sole purpose of recording "installed" conditions. Daily note all changes made in these drawings in connection with the final installation including exact dimensioned locations of all new underground utilities, services and systems and all uncovered existing active and inactive piping outside the building.

B. At contract completion, the Contractor shall provide an electronic file of the revised drawings. The Contractor shall transfer the information from the "blueline" prints maintained as described above, and turn over this neatly marked set of reproducible drawings representing the "as

installed" work to the Architect/Engineer for verification and subsequent transmittal to the Owner. The Contractor shall refer to Division 01 of these Specifications, and to the Uniform General Conditions, for additional information. These Drawings shall include as a minimum:

1. Addendum written Drawing changes.
2. Addendum supplementary Drawings.
3. Accurate, dimensioned locations of all underground utilities, services and systems.
4. Identification of equipment work shown on Alternates as to whether alternates were accepted and work actually installed.
5. Change Order written Drawing changes.
6. Change Order supplementary Drawings.

C. Electronic Media
   1. The Contractor shall submit three (3) compact discs containing all the Drawings in AutoCAD 2017 or 2018 format.

D. "As installed" plans shall bear a stamp, "stick-on decal" or lettered title block generally located in lower right hand corner of drawing entitled "AS INSTALLED DRAWING" with Company name of the installing trade Subcontractor and with a place for the date and the name of the responsible company representative.

E. In addition to the above, the Contractor shall accumulate during the progress of the job the following data, in duplicate, prepared in a neat brochure or packet folder and turn over to the Architect/Engineer for review, and subsequent delivery to the Owner.
   1. All warranties and guarantees and manufacturers' directions on equipment and material covered by the Contract.
   2. Two (2) sets of operating instructions for heating and cooling and other mechanical and electrical systems. Operating instructions shall also include recommended preventative maintenance and seasonal changeover procedures.
   3. Valve tag charts and diagrams specified herein.
   4. Approved wiring diagrams and control diagrams representing "as installed" conditions.
   5. Copies of approved shop drawings.
   6. Any and all other data and/or drawings required as submittals during construction.
   7. Repair parts list of all major items and equipment including name, address and telephone number of local supplier or agent.
   8. All of the above data shall be submitted to the Architect/Engineer for approval, and shall be corrected as instructed by the Architect/Engineer prior to submission of the final request for payment.

1.26 CUTTING AND PATCHING

A. General: Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.

B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for pipes shall be core drilled to exact size.

C. Restoration: All openings shall be restored to "as new" condition under the appropriate specification section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

E. Plaster: All mechanical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.

F. Special Note: No cutting, boring, or excavating that will weaken the structure shall be undertaken.

1.27 ROOF PENETRATIONS AND FLASHING

A. Pipe, sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided and installed by a qualified contractor for all roof penetrations. This shall be the responsibility of the General Contractor.

1.28 EXCAVATION, TRENCHING AND BACKFILL

A. Excavation (See Divisions 00 and 01 for special requirements related to excavation and trenching.):

1. The subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the drawings and/or required for the installation of piping. All exterior lines shall be installed with a minimum cover of 24," unless otherwise indicated. Generally, more cover shall be provided if grade will permit. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced. Trenches shall be not less than 12" wider nor more than 16" wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6" nor more than 8" in width is provided on each side of the pipe.
2. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes shall be dug after the trench bottom has been graded. Where inverts are not shown, grading shall be determined by the International Fire Code for the service intended and the size used. Bell holes for pipe joints shall be 12" in depth below the trench bottom and shall extend from a point 6" back of the face of the bell. Such bell holes shall be of sufficient width to provide ample room to complete the pipe joint . Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to ensure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used. Special pipe beds shall be provided as specified hereinafter.
3. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by workers especially skilled in this type of work. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required. Where rock excavation is required, the rock shall be excavated to a minimum over depth of 6" below the trench depths specified. The over depth rock excavation and all excess trench excavation shall be backfilled with sand. Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.
4. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of

trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the job site as directed by the Construction Inspector.

5. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided.
6. Excavate as required under the building in order that all piping, etc., shall clear the ground a minimum of 12" for a distance of 24" on either side. Edges of such excavations shall slope at an angle of not over 45 degrees with the horizontal unless otherwise approved by the Construction Inspector. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.
7. Trenches for water lines inside the building shall be properly excavated, following, in general, the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped and settled with water. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.
8. All surplus materials removed in these trenching operations becomes the property of the Contractor, and shall be disposed of at the expense of the Contractor, at a legal disposal site, off of the campus.

B. Backfilling

1. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches (304.8 mm) above the top of the pipe. The next layer and subsequent layers of backfill may be excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clods of earth or stones larger than 1-1/2" in diameter, flooded until the pipe has cover of not less than one foot. The remainder of the backfill material shall then be thrown into the trenches, moistened, and tamped or flooded in one-foot layers. Blasted rock, broken concrete or pavement, and large boulders shall not be used as backfill material. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and mounded over, and smoothed off.
2. Backfill under concrete slabs-on-fill shall be as specified above, shall be gravel, or shall be other such materials more suitable for the application. Installation and compaction shall be as required for compatibility with adjacent materials.
3. Opening and Re-closing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched, using materials to match those cut out. The patches shall thoroughly bond with the original surfaces and shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas.
4. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5 feet (152.4 cm) to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Construction Inspector before they are cut or damaged in any way. The Construction Inspector will give immediate instructions for the disposition of it. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the

excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

1.29 OPERATION PRIOR TO COMPLETION

A. When any piece of Fire Protection equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Project Manager's written permission to do so. The warranty period shall, however, not commence until the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, properly adjust and complete all deficiency list items prior to being started, commissioned and before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

1.30 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT

A. Check inspections shall include fire sprinkler piping, equipment, overall fire protection system controls, and such other items hereinafter specified or specifically designated by the Architect/Engineer.

B. Contractor shall fill out and submit a "Material and test certificate" in compliance with NFPA 13 – 10.10.0 AND receive fire marshal sign-off prior to 100% payment of underground portion of work.

C. Contractor shall fill out and submit a "Material and test certificate" per NFPA 13 – 16.1 AND receive fire marshal sign-off prior to payment of 100% for above ground work.

D. Third party inspections shall be completed prior to final payment.

E. Contractor shall perform work as required to comply with third party inspections.

1.31 COOPERATION AND CLEANUP

A. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job. Upon the completion of the job, each trade shall immediately remove all of his tools, equipment, any surplus materials and all debris caused by that portion of the work.

1.32 CLEANING AND PAINTING

A. All equipment and piping, etc., furnished and installed in exposed areas under Division 21 of these specifications and as hereinafter specified shall be cleaned, prepared, and painted according to the following specification. In the event of a conflict between the specifications referenced, the provisions of this specification shall prevail only for Division 21 work.

B. All purchased equipment shall be delivered to the job with a suitable factory protective finish with the colors hereinafter specified. The following materials shall not be painted: copper, galvanized metal, stainless steel, fiberglass, PVC, and PVDF.

C. Before painting, materials and equipment surfaces shall be thoroughly cleaned of cement, plaster, and other foreign materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metalwork shall be carefully brushed down with the steel brushes to remove rust and other spots and left smooth and clean.

D. Color of finish painting shall be painted in accordance with COH Standard Color Schedule for machinery spaces using Pratt and Lambert, Inc.'s "Effector" enamel, or approved equal. Two (2) coats shall be applied with a light tint first coat and deep color for final coat. Colors shall be as follows:

ITEM	COLOR	"P and L"

		PAINT NUMBER
Fire Protection Equipment and Piping	Safety Red	R131R (Vibrant Red)

1. Note that the paint specified above is included for purposes of establishing a QUALITY THAT shall be used on this Project. The proposed paint shall be submitted, and alternatives will be considered using the submittal procedures specified in this document.

E. Jacketing on insulation shall not be painted.

F. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible due to the painting operation.

G. Scope of painting for Division 21 Work in areas other than those defined as "exposed" is as follows:
   1. All uncovered steel pipe, supports, exposed pipe and hanger rod threads, and hangers in underfloor spaces shall be cleaned and painted with two (2) coats of Tropical Paint Co. No. 77-black asphaltic emulsion. Galvanized steel and copper lines in these spaces shall not be painted.
   2. All canvas finishes including those underfloor and in concealed spaces shall be painted with one sizing coat if not already sized, containing mildew resistant additive and Arabol adhesive prior to any other specified finish paint.
   3. All fire protection piping shall be painted whether concealed or exposed, in all areas of the project without exception. Fire protection piping shall be painted safety red. These "safety" colors shall be as defined by OSHA.
   4. If insulated, the piping shall be primed, only, prior to insulation, and the insulation jacketing shall be painted as specified for piping. The requirements of this paragraph are "primary" and have priority over any conflicting Specification or instruction, should a conflict in the Construction Documents exist.

PART 2 PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. All equipment installed shall have local representation, local factory authorized service, and a local stock of repair parts.

C. Responsibility for furnishing proper equipment and/or material and ensuring that equipment and/or material is installed as intended by the manufacturer, rests entirely upon the Contractor. Contractor shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

D. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of Work involved. All Work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job Site but shall be replaced with new materials and/or equipment.

E. Materials and equipment manufactured domestically are preferred when possible. Materials and equipment that are not available from a domestic manufacturer may be by a non-domestic manufacturer provided they fully comply with Contract Documents.

F. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating.

2.02 NAMEPLATES

A. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

B. Nameplates shall be black laminated rigid phenolic with white core. Nameplate minimum size shall be 1 inch (25.4 mm) high by 3 inches (76.2 mm) long with 3/16-inch-high engraved white letters.

C. Nameplate Fasteners: Fasten nameplates to the front of equipment only by means of stainless steel self-tapping screws. Stick-ons or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates.

D. Nameplate Information: In general, the following information is to be provided for the types of electrical components or enclosures supplied with equipment.
   1. Individual Starters, Contactors, Disconnect Switches, and Similar Equipment: Identify the device, and voltage characteristics source and load served.

2.03 WALL, FLOOR AND CEILING PLATES (ESCUTCHEONS)

A. Except as otherwise noted, provide stainless steel or chrome plated brass floor and ceiling plates around all pipes passing exposed through walls, floors or ceilings, in any spaces except underfloor and plenum spaces.

B. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines that are insulated and positively secured to such pipe or insulation.

C. For finished ceiling installation, secure escutcheons to ceiling with escutcheon fasteners.

D. Plates will not be required for piping where pipe sleeves extend ¾-inch or more above finished floor.

2.04 ROOF PENETRATIONS AND FLASHING

A. Pipe sleeves, pitch pockets and flashings compatible with the roofing installation shall be provided and installed for all roof penetrations by a contractor qualified in such Work. Installation shall comply with the Contract Documents and with FM General Data Sheets 1-28, 1-29, 1-31 & 1-49 along with the FM approval guide.

PART 3 EXECUTION

3.01 PREPARATION

A. Cooperate with trades of adjacent, related or affected materials or operations, and with trades performing continuations of this Work in order to effect timely and accurate placing of Work and to coordinate, in proper and correct sequence, the Work of such trades.

B. The size of equipment indicated on the Drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine that the equipment proposed will fit in the space. Fabrication Drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

C. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

D. Space Requirements:
   1. Consider space limitations imposed by contiguous Work in location of equipment and material. Do not provide equipment or material which is not suitable in this respect.
   2. Make changes in material and equipment locations of up to five (5) feet, to allow for field conditions prior to actual installation, and as directed by the Architect/Engineer at no additional cost to the Owner.

E. Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings. Should any equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations, as shown on the drawings and stated in the specifications.

C. Piping may be run exposed in rooms typically without ceilings such as mechanical rooms, janitor's closets, tight against pan soffits in exposed "tee" structures, or storage spaces, but only where necessary. Shutoff and isolation valves shall be easily accessible.

D. All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping and ducts run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.

E. Prior to the installation of any ceiling material, gypsum, plaster or acoustical board, the Contractor shall notify Project Manager so that arrangement can be made for an inspection of the above-ceiling area about to be "sealed" off. The Contractor shall provide written notification to the Owner at least five (5) calendar days prior to the inspection.

F. Precedence of Materials:
   1. The Specifications determine the nature and setting of materials and equipment. The Drawings establish quantities, dimensions and details.
   2. If interference is encountered, the following installation precedence of materials shall guide the Contractor to determine which trade shall be given the "Right of Way":
      a. Building lines
      b. Structural members
      c. Structural support frames supporting ceiling equipment
      d. Soil and drain piping
      e. Vent piping
      f. Supply, return and outside air ductwork
      g. Exhaust ductwork
      h. Condensate piping
      i. Fire protection piping
      j. Domestic water (cold and hot, softened, treated)
      k. Refrigerant piping
      l. Electrical conduit
   3. Coordinate fire protection system with other trade systems as required to maintain system right-of-ways.

3.03 TESTING

A. When any piece of equipment is operable and it is to the advantage of the Contractor to operate the equipment, Contractor may do so, provided that Contractor properly supervises the operation, and has the Project Manager's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of Substantial Completion, whichever occurs first.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean and properly adjust, and complete all deficiency list

items before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

C. The Contractor shall execute, at no additional cost to the Owner, any tests required by the Owner or the National Fire Protection Association (NFPA), ASTM, etc. standards listed. The Contractor shall provide all equipment, materials and labor for making such tests. The Owner will pay reasonable amounts of fuel and electrical energy costs for system tests. Fuel and electrical energy costs for system adjustment and tests, which follow Substantial Completion by the Owner, will be borne by the Owner.

D. Notify the Project Manager and the Architect/Engineer in writing at least five (5) calendar days or as agreed by the Project Manager prior to each test and prior to other Specification requirements requiring Owner and Architect/Engineer to observe and/or approve tests.

E. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel performing, observing and inspecting, description of the test and extent of system tested, test conditions, test results, specified results and other pertinent data. Data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance." The Contractor or Contractor's authorized job superintendent shall legibly sign all Test Log entries.

F. Maintain Log of Tests as hereinafter specified.

G. See Specifications hereinafter for additional tests and requirements.

H. Refer to Commissioning Specification Sections for additional Start-up, pre-functional and operational checkout, and for functional performance test procedures.

3.04 TRAINING

A. Operating and Maintenance Manuals and instruction shall be provided as specified under the Division 01 Section entitled "Project Closeout Procedures."

B. Specific training and operating instructions for individual equipment components shall be as specified in the individual Specification Sections.

END OF SECTION

SECTION 210529
FIRE PROTECTION HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASME B31.9 - Building Services Piping; 2025.

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2026.

D. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.

E. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

G. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2026.

H. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).

I. MFMA-4 - Metal Framing Standards Publication; 2004.

J. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

K. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems; 2024.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Fastener systems.
   5. Equipment supports.

B. Related Requirements:
   1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers.
   2. Metal framing systems.
   3. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers.
   2. Include design calculations for designing trapeze hangers.

1.05 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.06 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. NFPA Compliance: Comply with NFPA 13 and NFPA 14.

D. UL Compliance: Comply with UL 203.

2.02 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
   2. Galvanized Metallic Coatings: Pre-galvanized or hot-dip galvanized.
   3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.03 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with NFPA-approved, UL-listed, or FM-approved carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.04 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. B-line, an Eaton business.
      b. Flex-Strut Inc.
      c. Unistrut; Part of Atkore International.
   2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
   3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
   4. Channels: Continuous slotted carbon-steel channel with inturned lips.
   5. Channel Width: Selected for applicable load criteria.

6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Metallic Coating: Hot-dip galvanized.

2.05 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Not allowed.

B. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
      c. MKT Fastening, LLC.
   2. Indoor Applications: Zinc-coated or stainless steel.
   3. Outdoor Applications: Stainless steel.

2.06 EQUIPMENT SUPPORTS

A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.07 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout, suitable for interior and exterior applications.
   1. Properties: Non-staining, non-corrosive, and non-gaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.01 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.02 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal strut systems.

D. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.03 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.05 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (38 mm).

3.06 PAINTING

A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 099000 "Painting and Coating."

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.07 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
   3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
   4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
   5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
   6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
   7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
   8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
   9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

I. Hanger-Rod Attachments: Comply with NFPA requirements.

J. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. C-Clamps (MSS Type 23): For structural shapes.
3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

K. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

L. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

M. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 210553
FIRE PROTECTION PIPING AND EQUIPMENT IDENTIFICATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 21 00 00 – General Requirements for Fire Suppression.

B. Section 21 05 29 – Fire Protection Supports and Sleeves.

1.03 SECTION INCLUDES

A. Nameplates

B. Tags

C. Pipe Markers

1.04 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2026.

B. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.05 RELATED SECTIONS

A. Section 09 91 00 – Painting: Identification painting.

1.06 REFERENCES

A. ASME A13.1 – Scheme for the Identification of Piping Systems.

B. IFC - International Fire Code, 2021 edition.

C. NFPA 13 - Sprinkler System, Installation, 2019 edition.

1.07 SUBMITTALS

A. Submit under provisions of Section 21 00 00.

B. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for fire suppression equipment, piping and valve identification.
   1. Equipment Label Schedule: Provide a schedule of all equipment to be labeled with the proposed content for each label.
   2. Access Panel and Door Markers: Provide a schedule of all panels and doors to be labeled with the proposed content for each label.
   3. Pipe Label Schedule: Provide a schedule of each piping systems indicating a proposed nomenclature and location of all pipe markers.
   4. Valve Chart and Schedule: Provide a proposed valve numbering scheme and schedule for each piping system. Tabulate valve number, room or space location, function, valve manufacturer's name and model number, piping system, system abbreviation as shown on tag, normal-operating position (open, closed, or modulating), and variations for identification. Mark valves intended for emergency shut-off and similar special uses.
   5. Warning Tags: Provide a schedule of all equipment to be labeled with the proposed content for each label.

C. Product Data: Provide manufacturers' catalog literature for each product required, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

D. Samples: Submit two (2) of each type of label, tag, etc., of the approximate size specified of implied in the Specification.

E. Manufacturer’s Installation Instructions: Indicate special procedures, and installation.

1.08 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

1.09 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 21 00 00.

B. Record actual locations of tagged valves and update schedules accordingly.

1.10 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five (5) years documented experience

B. Installer Qualifications: Company specializing in performing Work of this section with minimum five (5) years documented experience.

C. ASME Standards: Comply with ASME A13.1 for color scheme, lettering size, length of color field, and viewing angles of identification devices.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging with labels clearly identifying product name and manufacturer until ready for installation.

B. Storage: Store materials in clean, dry area indoors until ready for installation.

C. Handling: Protect materials and finish from damage during handling and installation.

PART 2 PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them. All items of equipment such as fire pumps, etc., are to be clearly marked using engraved nameplates as specified. Use equipment identification numbers that appear on the design documents and/or equipment identification numbers furnished by the Owner’s Designated Representative.

C. General: Provide manufacturer's standard products of categories and types required for each application specified. For each identification type, provide all products from same manufacturer with same text, style, color, shape, and other identification features.
   1. Provide nameplates with the unit number on all mechanical equipment.
   2. Access panel and door markers for standpipes, hose and fire extinguisher cabinets, fire and smoke dampers, etc.
   3. Provide pipe identification labels including direction-of-flow arrows and with service indicated. All labels shall have background colors matched with specific service designation.
   4. Provide valve tag numbers on all valves.
   5. Warning tags at motors and equipment controlled by automatic starters, etc.

2.02 MANUFACTURERS

A. Equipment Tags, Valve Tags, and Markers:
   1. Marking Services, Inc.
   2. Seton, owned by Brady Corporation.
   3. Brady Corporation
   4. Graphic Products, Inc.
   5. Brimar Industries.
   6. Craftmark.

2.03 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Material and Thickness:
      a. Indoors: Multilayer, multicolor, plastic labels for fire suppression piping and equipment engraving, 1/8 inch (3.18 mm) thick, and having predrilled holes for attachment hardware.
      b. Outdoors: Chemically resistant plastic with printed graphics protected by a chemical and UV resistant top laminate.
   2. Letter Color: White
   3. Background Color: Red
   4. Maximum Temperature: Able to withstand temperatures up to 160 degrees Fahrenheit (71.11 degrees Celsius).
   5. Minimum Label Size: Length and width vary for required label content, but not less than 1 by 3 inches (76.2 mm).
   6. Minimum Letter Size: 1/4 inch (6.35 mm) for name of units if viewing distance is less than 24 inches (609.6 mm), 1/2 inch (12.7 mm) for viewing distances up to 72 inches (1828.8 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds (2/3) to three-fourths (3/4) the size of principal lettering.
   7. Fasteners: Stainless-steel self-tapping screws.

B. Label Content: Nomenclature on the label is to include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Use equipment identification numbers that appear on the design documents and/or equipment identification numbers furnished by the Owner.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

D. All scheduled equipment shall be identified with an Equipment Tag.

2.04 ACCESS PANEL AND DOOR MARKERS

A. Material and Thickness: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification.

B. Letter Color: White

C. Background Color: Red

D. Fasteners: Self-tapping, stainless steel screws or contact-type, permanent adhesive.

2.05 VALVE CHART

A. The Contractor shall prepare and install, in a suitable glazed anodized aluminum frame, typewritten valve charts giving the number, location, function and area or rooms served for each line valve installed under this contract.

B. Each valve shall be numbered on these charts in accordance with the system of which it is a part of and its location.

2.06 VALVE TAGS

A. Provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above.

B. Valve tags shall conform to ANSI A13.1.Valve Tags (Indoors): Stamped or engraved with 1/4 inch (6.35 mm) letters for piping abbreviation and 1/2 inch (12.7 mm) numbers.
   1. Tag Material: Brass, 0.032 inch (0.81 mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Background Color: Natural brass.
   3. Letter Color: Black.
   4. Tag Size: 1-1/2 inches (38 mm), round.
   5. Fasteners: Brass S-Hooks and Jack Chain.

C. Valve Tags (Outdoors):
   1. Material: Chemically resistant plastic with printed graphics protected by a chemical and UV resistant top laminate, and having stainless steel grommet protected predrilled holes with for attachment hardware.
   2. Background Color: Red.
   3. Letter Color: White.
   4. Tag Size: Minimum 1-1/2 inches (38 mm).
   5. Fasteners: Stainless steel S-Hooks and stainless steel Jack Chain.

2.07 PIPE LABELS (INDOOR PIPING)

A. Provide labels for above ground piping located indoors, and not exposed to sunlight or a harsh environment.

B. Pipe labels shall pre-printed, color-coded, with lettering indicating service, and showing flow direction in conformance with ANSI A13.1 as indicated below.

PIPE CONTENTS	LABEL ABBREVIATION	LABEL COLORS (BACKGROUND/TEXT)
FIRE SUPPRESSION WATER	FIRE	RED/WHITE
WET SPRINKLERS	WET FIRE	RED/WHITE

C. Lettering shall be sub-surface printed and protected from direct contact by a layer of plastic. Markers with surface printed lettering will not be accepted.

D. Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.

E. Plastic Labels for Pipe O.D. less than 8 inches (203.2 mm): Factory fabricated, flexible, semi-rigid plastic, preformed to fit around full circumference pipe or pipe covering and to attach to pipe without fasteners or adhesive in contact with the pipe surface.

F. Pipe Labels for Pipe O.D. 8 inches (203.2 mm) and Over: Strap-on, semi rigid plastic to cover partial circumference of pipe and to attach to pipe with nylon ties.

G. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches (38 mm) high.

H. Pipe markers and arrow markers also shall be provided for all piping systems.

2.08 PIPE LABELS (OUTDOOR PIPING)

A. Provide labels for above ground piping located outside, and exposed to sunlight or a harsh environment, the following product is specified.

B. Pre-printed, color-coded, with lettering indicating service, and showing flow direction.

C. Pipe markers shall be constructed of printed 5 mil (0.127 mm) polyester and top laminated with ultraviolet and chemical resistant plastic film that is engineered to provide maximum durability of the printed legend. Markers shall be pre-coiled to wrap entirely around the circumference of pipe up to 10 inch outside diameter, and self-sealed with a strip of clear ultraviolet and chemical resistant plastic film. Coiled markers shall seal to themselves, and not the pipe surface.

D. Pipe Labels for pipe O.D. up to 10 inches (254 mm): Shall be labeled with a single piece, pre-printed marker that wraps entirely around the circumference of the pipe, overlaps and seals to itself rather than adhere to the pipe surface.

E. Pipe Labels for pipe O.D. 10 inches and greater: Shall be constructed of printed 5 mil (0.127 mm) polyester and top laminated with clear ultraviolet and chemical resistant plastic film that is pre-applied to an acrylic-faced, co-extruded ABS plastic carrier. Carrier shall have pre-formed legs running the entire length of the part to ensure marker remains straight and aligned with pipe. Flow direction shall be identified by application of a separate arrow label of same construction. Carriers shall be affixed to piping by means of two (2) stainless steel straps that wrap entirely around the circumference of the pipe.

F. Underground Plastic Pipe markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil (0.1016 mm) thick, manufactured for direct burial service.

2.09 CEILING TACKS

A. Description: Steel with 3/4 inch (19.05 mm) or 7/8" diameter color coded head.

B. Color code: Red.

2.10 CEILING GRID TAG FOR EQUIPMENT LOCATED ABOVE LAY-IN CEILING

A. Description: 3/4" x variable length vinyl label, 3.0 mil (0.0762 mm) self-adhesive vinyl similar to Graphic Products, Inc. DuraLabel Pro™. Label color shall be black text on a white background.

B. All scheduled equipment above finish lay-in ceiling shall be identified with an Equipment Tag.

C. All ceiling grid tags shall be installed prior to the ceiling cover inspection.

2.11 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.18 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (19.05 mm).

F. Minimum Letter Size: 1/4 inch (6.35 mm) for name of units if viewing distance is less than 24 inches (609.6 mm), 1/2 inch (12.7 mm) for viewing distances up to 72 inches (1828.8 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds (2/3) to three-fourths (3/4) the size of principal lettering.

G. Fasteners: Stainless-steel self-tapping screws.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.12 WARNING TAGS

A. Material: Reprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.

B. Size: 3 by 5-1/4 inches (133 mm) minimum.

C. Fasteners: Brass grommet and wire.

D. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

E. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Install identifying devices after completion of coverings and painting.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulates.

B. For pipe markers that are pre-coiled or strap-on type and do not adhere directly to the piping, no surface preparation is necessary.

3.03 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

3.04 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of fire suppression equipment.

B. Locate equipment labels where accessible and visible.

3.05 ACCESS PANEL AND DOOR MARKERS INSTALLATION

A. Install or permanently fasten markers on access panels and door for fire suppression equipment.

B. Locate labels where accessible and visible.

3.06 VALVE TAGS INSTALLATION

A. Contractor(s) shall provide and install valve tags on all valves installed within this Project, except check valves and valves within factory-fabricated equipment units..

B. List tagged valves in a valve schedule.

3.07 PIPE LABEL INSTALLATION

A. Piping runs throughout the Project including those above lift-out ceilings, underfloor and those exposed to view when access doors or access panels are opened shall be identified by means of pipe markers. Concealed areas, for purposes of this identification section, are those areas that cannot be seen except by demolition of the building elements. In addition to pipe markers, arrow markers shall be used to indicate direction of flow.

B. As a minimum, locate pipe markers as follows:
   1. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several valves exist on one (1) header, it is necessary to mark only the header.

2. Every 20 feet (609.6 cm) in exposed and concealed areas on all piping systems. Provide at least one (1) pipe marker in each room on all piping systems.
3. At each branch or riser takeoff on piping systems.
4. Provide a pipe marker and an arrow marker at every point of pipe entry or exit where the pipe penetrates a wall, floor, service column or enclosure.
5. At access doors, manholes and similar access points that permit view of concealed piping.
6. Near major equipment items and other points of origination and termination.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.

D. Provide a double-ended arrow marker when flow can be in either or both directions.

E. Install plastic tape, and pipe markers completely around pipe in accordance with manufacturer's instructions.

F. Locate markers on the two (2) lower quarters of the pipe where view is unobstructed.

G. Install underground plastic pipe markers 6 to 8 inches (203.2 mm) below finished grade, directly above buried pipe.

3.08 WARNING TAGS INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.09 CEILING TACKS INSTALLATION

A. Mark location of equipment or valves located above ceilings with identifying "buttons" to help in identification for maintenance.

3.10 CEILING GRID TAGS INSTALLATION

A. Provide ceiling grid tags to locate valves or other concealed equipment above T-bar type panel ceilings. Locate in corner of grid closest to equipment.

3.11 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 210800
COMMISSIONING OF FIRE PROTECTION SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes commissioning process requirements for Fire Protection systems, assemblies, controls, and equipment.

B. This project will have selected building systems commissioned. The equipment and systems to be commissioned are specified “SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS”.

C. The scope of commissioning shall include the third party inspections, site verification of entire system, witness and verification of the “material and test certificates”

1.02 RELATED SECTIONS

A. SECTION 01 91 00 - COMMISSIONING GENERAL REQUIREMENTS

B. SECTION 22 08 00 – COMMISSIONING OF PLUMBING SYSTEMS

C. SECTION 23 08 00 – COMMISSIONING OF HVAC SYSTEMS

D. SECTION 26 08 00 – COMMISSIONING OF ELECTRICAL SYSTEMS

E. SECTION 28 08 00 – COMMISSIONING OF FIRE ALARM SYSTEMS

1.03 DEFINITIONS

A. Refer to section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

1.04 SUBMITTALS

A. Certificate of Readiness, signed by the Contractor, certifying that systems, assemblies, equipment, components, and associated controls are ready for testing.

B. Manufacturer’s completed start-up reports for equipment and systems.

1.05 CONTRACTOR'S RESPONSIBILITIES

A. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for details of contractor’s responsibilities related to commissioning.

B. Perform commissioning tests at the direction of the CxA.

C. Attend commissioning meetings.

D. Provide information requested by the CxA for functional testing and for final commissioning documentation.

E. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

F. Functional testing of systems will be carried out solely by contractor’s personnel, under the direction of CxA. Provide experienced personnel, familiar with the systems being installed under this project.

1.06 CXA'S RESPONSIBILITIES

A. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

B. CxA will direct commissioning testing. Commissioning provider shall coordinate and provide, licensed, third party inspection prior to final payment. Inspection to include flow test and overhead inspection.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL TESTING REQUIREMENTS

A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in Division 21 Sections. Provide submittals, test data, inspector record, and certification to the CxA.

B. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Mechanical systems.

C. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

E. Tests will be performed using design conditions whenever possible.

3.02 SYSTEM START-UP

A. Contractor is solely responsible for system start-up. CxA may, at his discretion, witness start up procedures, but will not perform any Functional Testing of systems until Contractor has completed start-up and resolved all operating deficiencies, and has so certified.

3.03 TESTING PREPARATION

A. Certify that Fire Protection systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that testing, adjusting, and balancing procedures for Fire Protection systems have been completed and submitted, discrepancies corrected, and corrective work approved.

C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

D. Inspect and verify the position of each device and interlock identified on checklists.

E. Check safety cutouts, alarms, and interlocks with life-safety systems during each mode of operation.

3.04 FUNCTIONAL TESTING / GENERAL

A. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Plumbing systems.

B. Provide measuring instruments to record test data as directed by the CxA.

3.05 PIPING SYSTEMS

A. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 22 piping Sections. Plumbing Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Include sequence of testing and testing procedures, description of equipment for flushing operations, drawings for each pipe sector, showing the physical location of each designated pipe test section, minimum flushing water velocity, and chemical treatment plan.

3.06 DEFERRED TESTING

A. Initial commissioning will be done as soon as contract work is completed, though building may not be at full occupancy and equipment may not be at full loading.

B. If adequate load may be artificially placed upon heating or cooling equipment, CxA, at his discretion, may perform functional testing during non-peak load periods. If testing cannot be

carried out under these conditions to adequately verify system performance, testing will be deferred until such time as conditions are more satisfactory.

1. Contractor is to provide services of personnel and participate in deferred or seasonal testing process in the same manner as he would in non-seasonal testing.
2. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.07 RE-TESTING

A. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of re-testing of Plumbing systems.

3.08 SYSTEMS TO BE COMMISSIONED

A. Reference Project Specification Section 01 91 00 COMMISSIONING GENERAL REQUIREMENTS for list of Fire Protection systems to be commissioned.

END OF SECTION

SECTION 211000
WATER BASED FIRE SUPPRESSION SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall provide all components required for the complete installation of automatic sprinkler systems as hereinafter specified and indicated on the Drawings.

B. System Layout: The fire sprinkler areas, piping, head locations, etc. as indicated is only for Contractor's reference as to areas to be protected and possible piping routes. If header or manifold sizes are given in the drawings, then the sizes given shall be the minimum sizes installed. Actual number, spacing and location of heads, size and routes of piping shall be provided in accordance with the applicable Specifications and acceptable Shop Drawings. All layouts, head spacing, coverage, etc., as may be required by the referenced authorities and/or Architectural and Structural conditions shall be made without increase in cost to the Owner or the Architect/Engineer. Modifications to head spacing, pipe routes, etc. shall be closely coordinated with the work of all other trades. The Fire Sprinkler Subcontractor shall be responsible for the design and installation of the fire sprinkler system as described herein and on the project drawings. The piping of the system shall be sized used the "hydraulic" method, as included in NFPA Standard No. 13. Piping sized using the "schedule" method is unacceptable.

1.02 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 21 00 00 – General Requirements for Fire Suppression

B. Section 21 05 29 – Fire Protection Supports and Sleeves

C. Section 21 05 53 – Fire Protection Piping and Equipment Identification

1.03 SECTION INCLUDES

A. Pipe, fittings, valves, and connections for sprinkler system.

1.04 REFERENCE STANDARDS

A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2026.

B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

C. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2021.

D. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.

E. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings; 2024.

F. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded; 2021.

G. ASME B16.25 - Buttwelding Ends; 2022.

H. ASME B36.10 - Welded and Seamless Wrought Steel Pipe; 2022.

I. ASME BPVC - Boiler and Pressure Vessel Code; 2025.

J. ASTM A536 - Standard Specification for Ductile Iron Castings; 2026a.

K. ASTM B32 - Standard Specification for Solder Metal; 2020.

L. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions; 2018, with Errata (2023).

M. MSS SP-67 - Butterfly Valves; 2022.

N. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.

O. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

P. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

Q. NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their Appurtenances; 2025.

1.05 RELATED SECTIONS

A. Section 31 23 16.13 – Trenching

B. Section 09 91 00 - Painting

1.06 REFERENCES

A. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.

B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.

C. ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.

D. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.

E. ANSI/ASME B16.9 - Factory-made Wrought Steel Buttwelding Fittings.

F. ANSI/ASME B16.11 - Forged Steel Fittings, Socket-welding and Threaded.

G. ANSI/ASME B16.25 - Buttwelding Ends.

H. ANSI/ASME B36.10 - Welded and Seamless Wrought Steel Pipe.

I. ANSI/ASME Boiler and Pressure Vessel Code (BPVC), Sec IX - Welding and Brazing Qualifications.

J. ANSI/ASTM A135 - Electric-Resistance-Welded Steel Pipe.

K. ANSI/ASTM A47 - Malleable Iron Castings.

L. ANSI/ASTM B32 - Solder Metal.

M. ANSI/AWS A5.8 - Brazing Filler Metal.

N. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings.

O. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast.

P. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.

Q. ASTM A120 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated (Galvanized) Welded and Seamless, for Ordinary Uses.

R. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

S. ASTM A795 - Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.

T. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.

U. IFC - International Fire Code, 2021 edition with City of Houston, Texas amendments.

V. NFPA 13 - Installation of Sprinkler Systems, 2019 edition.

W. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances

X. NFPA 51B - Standard for Fire Prevention During Welding, Cutting, and Other Hot Work.

Y. UL - Fire Protection Equipment Directory.

Z. City of Houston, Texas, Fire Department Standards.

AA. State of Texas, State Fire Marshal Rules.

BB. All hose threads, coupling types, etc., utilized in the fire protection systems shall conform to the standards and requirements of the City of Houston, Texas Fire Department.

1.07 SUBMITTALS

A. Submit under provisions of Section 21 00 00.

B. Shop Drawings:
   1. Prior to detailed submission, submit preliminary layout showing head locations within coordinated ceiling grid and inspector's test station locations for review by Architect/Engineer.
   2. Submit shop drawings and obtain approval from all authorities prior to material purchasing, fabrication of any piping or installation of any components of the fire protection systems. Include detailed plans showing all piping, elevations of piping above finished floors, pipe sizes, hangers, supports, sprinkler heads, valves, siamese connections, concrete thrust block details, inspector's test locations, system drains, etc. Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
   3. Hydraulic calculations: Submit flow test results and comprehensive hydraulic data sheets complying with NFPA 13. Verification of the adequacy of water pressure and other pertinent water supply data shall be the responsibility of the design engineer.
   4. Sprinkler heads shall be shown on Drawings and specifically identified by the style or series designation as published in the appropriate agency listing or approval.
   5. Design systems under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas. All design submittal documents and shop drawings, including drawings and hydraulic calculations, shall bear the Responsible Engineer's signed and dated seal. Include all costs for obtaining approval from a Professional Engineer licensed in the State of Texas.

C. Product Data: Provide data on pipe materials, pipe fittings, sprinkler heads, valves, fire hose cabinets, flow switches, tamper switches, all other components and accessories. , Include manufacturer's catalogue information, code and standards compliance, performance ratings rough-in details, weights, support requirements, and piping connections.

D. Samples: Submit one (1) of each style of sprinkler head specified.

E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds requirements specified, and suggested by listed codes.

F. Certification of Installation: Provide a letter of certification stating that the installed and tested fire protection systems comply with the requirements of NFPA. The certification letter is to be authored, sealed, dated and signed by a licensed Fire Protection Engineer experienced in design and installation of this work and licensed in the state of Texas. Include all costs for obtaining approval from the licensed Fire Protection Engineer.

G. Provide certificate of compliance from authority have jurisdiction indicating approval of field acceptance tests.

H. Project Record Documents
   1. Submit under provisions of Section 21 00 00.
   2. Record actual locations of sprinkler heads and deviations of piping from drawings. Indicate drain and test locations.

1.08 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 21 00 00.

B. Maintenance Instructions: Include installation instructions, spare parts lists, procedures, and treatment programs.

1.09 QUALITY ASSURANCE

A. Sprinkler Systems: Perform work to NFPA 13.

B. Welding Materials and Procedures: Perform to ASME BPVC, Section IX.

C. Equipment and Components: Bear FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

D. Maintain one (1) copy of each document on site.

E. Qualifications of the Installer: The system shall be installed by a firm regularly engaged in the design and installation of automatic sprinkler systems in accordance with requirements of the National Fire Protection Association and Fire Protection and the Texas Department of Insurance Fire Sprinkler Rules, or by an authorized agent of such firm. Evidence to support the above requirements may be required and any proposed installer who cannot show suitable experience will be rejected.

F. Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas. All design submittal documents and shop drawings shall bear the Responsible Engineer’s signed and dated seal.

G. All parts of fire protection piping systems shall conform to all provisions of Underwriters' Laboratories requirements. All equipment shall bear the Underwriters' Laboratories label of approval.

H. Determine volume and pressure of incoming water supply from residual pressure water flow test.

1.10 DELIVERY, STORAGE, AND HANDLING

A. All materials shall be new, undamaged, and free of rust.

B. Deliver, store, protect, and handle products to site under provisions of Section 21 00 00.

C. Deliver and store valves in shipping containers with labeling in place.

D. Inspect shipments for possible damage during transit. Do not use damaged materials in any part of the system.

E. Provide temporary protective coating on cast iron and steel valves. fittings and valves not packaged within containers. Maintain in place until installation.

F. Protect all materials that are to be installed within this Project from exposure to rain, freezing temperatures and direct sunlight. EXCEPTION: Materials manufactured for exterior locations.

G. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.11 EXTRA MATERIALS

A. Furnish under provisions of Section 21 00 00.

B. The Contractor shall provide spare heads equal to one percent (1%) of the total number of heads installed under the Contract, but not less than ten (10).

C. The heads shall be packed in a suitable wall mounted metal storage cabinet and shall be representative of, and in proportion to, the number of each type and temperature rating heads installed. The cabinet shall be located where directed by the Construction Inspector.

D. In addition to the spare heads, the Contractor shall provide not less than one (1) special sprinkler head wrench for each type of head.

1.12 WARRANTY

A. The complete system shall be warranted in writing against defects in materials or Workmanship under normal use and service for a period of one (1) year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. All piping, materials and equipment used in the installation of sprinkler system shall be new and listed as approved by the Underwriters' Laboratories, Inc., List of Inspected Fire Protection Equipment and Materials and the Factory Mutual Testing Laboratories List of Approved Equipment, Fire Protection Devices and Devices Involving Fire Hazard and shall be the latest design of the manufacturer.

C. Pressure ratings of pipe, fittings, valves, gauges and all other water carrying appurtenances shall be suitable for the anticipated system pressures in which they are installed.

D. The installing Contractor shall identify piping, fire department connections, valves and hydraulic design information in accordance with applicable NFPA Standards.

2.02 UNIONS

A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of the system. No unions will be required in welded lines. Unions 2 inch (50.8 mm) and smaller shall be Class 300 AAR threaded malleable iron unions with iron to brass seats, and 2-1/2 inch (64 mm) and larger shall be ground flange unions. Companion flanges on lines at various items for equipment machines and pieces of apparatus shall serve as unions to permit removal of the particular items.

2.03 FLANGES

A. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A181 Grade I or II or A105-71 as made by Tube Turns or Hackney-Ladish Company. Slip on flanges shall not be used. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random.

B. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications.

C. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. All thread rods will not be an acceptable for flange bolts.

D. Flat faced flanges shall be furnished to match 125 lb cast iron flanges on pumps, check valves, strainers, etc. with full flange gaskets. Bolting of raised face flanges to flat faced flanges is not allowed.

2.04 FLANGE GASKETS

A. Gaskets shall be placed between the flanges of all flanged joints.

B. Gaskets shall be ring form gaskets fitting within the bolt circle of their respective flanges. Gaskets shall be 1/16" thick asbestos free material recommended for service by Anchor Seals, Garlock, or John Crane. The inside diameter of such gaskets shall conform to the nominal pipe size and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.

C. Spares: Contractor shall provide ten (10) spare gaskets for every flange size and rating.

2.05 WALL, FLOOR AND CEILING PLATES

A. See Section 21 00 00.

2.06 SLEEVES, INSERTS, AND FASTENINGS

A. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, etc., shall be sleeved. Refer to Specification Section 21 05 29.

2.07 UNDERGROUND FIRE PROTECTION PIPING

A. Acceptable Manufacturers: Pipe and joints shall be as manufactured in the United States by American Cast Iron Pipe Company, Tyler Pipe (a Division of McWane), U.S. Pipe Company, McWane Cast Iron Pipe Company, or Engineer accepted equivalent.

B. Pipe
   1. ANSI A21.50 (AWWA C150) and ANSI A21.51 (AWWA C151) cement mortar lined ductile iron, supplied in 16 feet (487.68 cm) laying lengths.
   2. Thickness
      a. Piping 4" and Smaller: Class 51.
      b. Piping 6" and Larger: Class 50.

C. Fittings
   1. Class 250 AWWA C110, cement mortar lined, ductile or gray iron, standard thickness.
   2. Tappings in ductile iron pipe shall be made with dual compression seal tapping sleeve, similar and Architect/Engineer accepted equivalent to U.S. Pipe Model T-28.
   3. Joints
   4. Ductile Iron Pipe to Ductile Iron Pipe: Unless noted otherwise on the Drawings, all joints shall be restrained mechanical joints.
   5. Ductile Iron Pipe to Steel Iron Pipe: ANSI/AWWA C110 flanged fittings adequate for 250 psi (1723.69 kPa) working pressure. Provide with dielectric flange insulating kit with insulating sleeves and washers for each bolt.
   6. Pipe to Valve: ANSI/AWWA C110 flanged fittings adequate for 250 psi (1723.69 kPa) working pressure.
   7. Bolts: High strength, Type 316 stainless steel tee head bolts with hexagon nuts.
   8. Gaskets: ANSI A21.11 / AWWA C111 ethylene propylene diene monomer (EPDM) suitable for 220°F.

D. Coating: Pipe and fittings shall be cement mortar lined. Coat pipe and fittings outside with the manufacturer's standard asphaltic sealcoat in accordance with the latest revision of ANSI Standard A21.4 (AWWA C104) suitable for domestic water service.

E. Casing: Unless otherwise noted on the Drawings, all ductile iron pipe, fittings, etc., shall be encased in 8 mils (0.2032 mm) thick polyethylene tubing in accordance with the latest revision of ANSI Standard A21.5 (AWWA C105).

F. Ductile iron piping, fittings, and joints shall be suitable for the minimum working pressure and sizes indicated on the Drawings, in Type 4 laying conditions with 2 to 15 feet (457.2 cm) of cover, and as required for freeze protection, unless otherwise indicated on the Drawings.

2.08 ABOVE GROUND FIRE PROTECTION PIPING

A. All pipe used for fire protection fire sprinkler systems shall be Schedule 40 black steel pipe conforming to ASTM A795 or ASTM A53. All piping 2-1/2" and larger shall be welded, unless otherwise indicated herein.

B. Use of mechanically coupled grooved piping, when approved by City of Houston, shall be “roll” grooved type; cut grooved pipe is not permitted.

C. Schedule 10 and “thin wall” fire sprinkler pipe is not permitted.

D. Fittings:
   1. Piping 2" and Smaller: Class 150 malleable iron threaded fittings conforming to ASME B16.3.
   2. Piping 2-1/2" and Larger: Welding type steel fittings conforming to ASTM A234 and ANSI B16.9. In lieu if welding type fittings, grooved type fittings may be used on sprinkler

systems. Pipe size changes shall be performed through the use of reducing tees or reducers designed for that purpose. The use of bushings is explicitly prohibited.

3. Grooved end couplings 2-1/2" and larger shall be Victaulic Style 07 “Zero-Flex” Rigid Coupling, with EPDM gasket (minimum 700 psi (4826.33 kPa) working pressure) for use with roll grooved piping. Products by Victaulic and Anvil are acceptable, or Engineer-approved equal. Reducing type couplings, outlet couplings, “T” outlet fittings, cut-in style fittings, snap joint couplings, and flange adapter type fittings are not acceptable. Provide grooved fittings similar to standard weld fittings.
4. Extra heavy "Thread-o-lets" shall be used at each point of departure from the riser to the fire hose or valve cabinet. A "Thread-o-let" shall be installed below the level of the valve in the cabinet and a minimum of two (2) threaded ells shall be used to provide a swing joint connection from the riser to the valve in the cabinet.

2.09 VALVES

A. General:
   1. All shutoff valves shall be UL listed and FM approved for fire protection service.
   2. Similar types of valves shall be the product of one manufacturer; i.e., all butterfly valves shall be of the same manufacture, all ball valves shall be of the same manufacture, etc.
   3. All valves used to control the flow of water to and within sprinkler systems shall be listed indicating type complete with electric supervisory switches. Coordinate wiring with the Electrical Contractor.

B. Shutoff valves for sizes 2 inch (50.8 mm) and smaller:
   1. Two (2) piece bronze ball valve, bubble-tight shutoff, full port, blow-out proof stem, chrome plated brass ball and silicon bronze stem, threaded end connections, conforming to MSS SP-110.
   2. One (1) piece, butterfly valve, full port, threaded ends, bronze housing and body, stainless steel disc. EPDM disc seal and slow closing.
   3. All valves shall be furnished with two (2) factory mounted internal supervisory switches.

C. Shut off valves for sizes over 2 inch (50.8 mm):
   1. Butterfly valves lug type with EPDM molded in seat liner, ductile iron disc, stainless steel stem, manual gear operator, conforms to MSS SP-67 and MSS SP-25, with integral supervisory switch. Where a grooved piping system is allowed, grooved end type butterfly valves may be used, consisting of ductile iron body and disc EPDM seats, stainless steel stem. Valves shall be equipped with internal supervisory switch.
   2. Gate valves – OS&Y (Outside Yoke and Stem) resilient wedge, epoxy coated interior and exterior, ASTM A536 ductile iron valve body, bonnet and resilient wedge, ASTM B150 stem and flanged ends.

D. Check valves for sizes 2 inch (50.8 mm) and smaller:
   1. Horizontal swing, bronze body, conforming to MSS SP-80, threaded ends and rubber disc.

E. Check valves for sizes over 2 inch (50.8 mm):
   1. Iron body swing-check, bronze disc, seat ring and hinge pin, UL listed and FM approved, flanged ends, renewable seats and disc, tapped 3/4 inch (19.05 mm) for ball drip assembly.

F. Standard of Quality for Fire Protection Valves:

SIZE	TYPE	CLASS	MANUFACTURER
2" AND SMALLER	**BALL**	**300**	**NIBCO NO. KT-505-W-8,** **STOCKHAM NO. T-255-FB-P-UL**

SIZE	TYPE	CLASS	MANUFACTURER
2" AND SMALLER	BUTTERFLY	175	MILWAUKEE NO. BB-SC02
2-1/2" AND LARGER	BUTTERFLY (LUG)	250	NIBCO NO. LD3510-8
2-1/2" AND LARGER	BUTTERFLY (GROOVED)	300	NIBCO NO. GD-4765-8N
2 " AND SMALLER	CHECK	200	NIBCO NO. KT-403-W
2-1/2" AND LARGER	CHECK	175	NIBCO NO. F-908-W
2-1/2" AND LARGER	CHECK (GROOVED)	250	NIBCO NO. G-917 W

2.01 WET PIPE FIRE SPRINKLER SYSTEM

A. System Description:
   1. System to provide coverage for entire building.
   2. Provide system to the NFPA 13 occupancy requirements listed below, unless otherwise noted. Refer to “FP” drawings for locations of design densities of specific rooms and areas.

LOCATION	SYSTEM TYPE/HAZARD
ADMINISTRATIVE AND MEETING ROOMS	LIGHT HAZARD
MECHANICAL EQUIPMENT ROOMS	ORDINARY HAZARD, GROUP 1
ELECTRICAL EQUIPMENT ROOMS	ORDINARY HAZARD, GROUP 1
GENERAL STORAGE AREAS	ORDINARY HAZARD, GROUP 1

   3. Interface system with building fire and smoke alarm system.
   4. Systems subject to freezing shall utilize antifreeze liquid. DRY PIPE SYSTEMS ARE NOT ALLOWED.

2.02 SPRINKLER HEADS

A. Acceptable Manufacturers: Victaulic, Grinnell (Tyco), Viking, Star or Reliable.

B. Suspended Ceilings and Gypsum Board or Plaster Ceilings:
   1. Type: Concealed pendant type, flexible concealed pendant, quick response.
      a. Finish: Factory finished (no field painting) cover plate, color to match ceiling finish. Exception: Provide chrome plated or alternate color cover plates where directed by Architect.
      b. Flexible sprinklers are permitted only in drop ceilings. Flexible sprinkler piping shall have UL-listed braided, angular corrugated flexible sprinkler hose. Hose shall have a minimum 2 inch (50.8 mm). bend radius and hose shall not have any bend connection restrictions without affecting hydraulics and safety of the material.
   2. Escutcheon Plate Finish: Standard white or chrome plated as selected by Architect.
   3. Operating Element: Fusible solder link or glass bulb type temperature rated for specific area hazard.
   4. Model: Sprinklers manufactured by Reliable, Victaulic or approved equal.

C. Exposed Area Type (for areas such as mechanical rooms, electrical rooms, etc.):
   1. Type: Standard upright or pendent type with guard, quick response.
   2. Head Finish:
      a. Conditioned spaces: Bronze.
      b. Non-conditioned Spaces/Exterior: Corrosion resistant material (i.e. PTFE or Electroless Nickel PTFE).
   3. Operating Element: Fusible solder link or glass bulb type temperature rated for specific area hazard.
   4. Model: GFR with appropriate wire guard as manufactured by Reliable or approved equal.

D. Extended coverage sprinkler heads are not to be used.

E. Sprinkler heads in elevator hoistways and elevator equipment rooms to be 200 degree F rated.

F. Use only quick response sprinkler heads.

G. Cold Rooms (≤ 42°F) and Areas Below Heated Ceiling/Soffit Spaces Susceptible to Freezing: Provide dry pendant type with chrome finish and two-piece escutcheon. (Areas include but not limited to; walk-in freezers, exterior overhangs, canopies.)

H. Elevator Equipment Rooms: Provide 212°F intermediate temperature classified heads.

I. Water Alarm:
   1. A water motor alarm shall be connected to each alarm valve and shall discharge to a brass alarm gong located on the exterior of the building as directed by the Architect. Alarm gong finish to be selected by the Architect.
   2. The alarm valves shall be Underwriters' Laboratories approved, wet type, connected to water supply and indicated on the Shop Drawings. Each alarm valve shall be provided with a circuit closer. Valves shall conform to the equipment of NFPA 13, complete with retarding chamber and pressure switch.

J. Water Flow Alarm Switch:
   1. Provide, where indicated on the Drawings, McDonnell UL approved line size flow switches.
   2. Flow switch shall be provided with delay, adjustable up to 90 seconds (60 to 90 seconds in Austin). See Division 26 for electrical signal connection by others to these flow switches.

2.03 FIRE DEPARTMENT SIAMESE CONNECTIONS

A. At the points designated on the accompanying Drawings, install Siamese fittings required for fire protection purposes. From a point on the incoming water supply line, the Contractor shall extend water line for fire protection purposes to Siamese connections.

B. Provide 2-way wall type Siamese connection equal to Potter Roemer No. 5750 series double clapper flush type Siamese connections with 2-1/2″ outlets having threads complying with the requirements of the Fire Department of the City of Houston, Texas. They shall have proper caps with pin type lugs attached to the body of the Siamese connections with substantial chains. The plate fitting against the building shall have raised letters reading "AUTOMATIC SPRINKLER". All external surfaces shall be chromium plated polished surfaces or as directed by Architect.

C. Provide 2 way free standing type Siamese shall be equal to Potter-Romer No. 5760 series cast brass body with 2-1/2" outlets and escutcheon. They shall have proper caps with pin type lugs attached to the body of connection with substantial chains. "AUTOMATIC SPRINKLER" is to be cast on head of connection. All external surfaces shall be chromium plated polished surfaces or as directed by Architect.

D. Provide hose threads complying with the requirements of the local Fire Department.

E. Products manufactured by Potter Roemer, Elkhart Brass or Larsen’s will be acceptable.

PART 3 EXECUTION

3.01 PREPARATION - ALL SYSTEMS

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Flush entire system of foreign matter prior to installation of sprinkler heads.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Install all materials and products in accordance with manufacturer's published recommendations. Use tools manufactured for the installation of the specific material or product.

C. Sprinkler Systems
   1. Install piping in accordance with NFPA 13 for sprinkler systems and NFPA 24 for service mains. Note that the piping sizes indicated in the plans are the minimum acceptable. The Qualified Contractor shall provide proper sizes, materials and installation as required in the appropriate NFPA Standard.
   2. Note that the use of piping bushings for any purpose is explicitly prohibited.
   3. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient. See Sections 21 00 00 and 21 05 29 for additional requirements.
   4. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
   5. Locate concealed valves, switches and alarm connections in accessible location, and coordinate size and location of access panels/doors with General Contractor.
   6. Install valves with stems upright, not inverted. All valves shall be located such that the removal of their bonnets is possible. Valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings. Any change in valve location must be so indicated on the Record Drawings. Remove protective coatings after installation.
   7. Provide drain valves at main shut-off valves, low points of piping and apparatus. Provide Fire Department test station, piped to drain.
   8. Locate outside alarm gong on building wall as indicated on the Drawings.
   9. Place pipe runs to conserve building space, and to minimize obstructions with other work. Group piping whenever practical at common elevations. Coordinate closely with work of other trades to avoid conflicts and provide all required offsets, piping, auxiliary drains, etc. to properly install system.
   10. Place piping in concealed spaces above finished ceilings. Run piping as high as possible, but a minimum of 12 inches (304.8 mm) above ceilings or proposed ceilings. Locate piping to avoid obstructing other work, including required service access to equipment furnished by other Divisions.
   11. Heads shall be located in a symmetrical pattern related to ceiling features such as grid, beams, light fixtures, diffusers, etc., and where applicable, heads shall be located symmetrically with the ceiling grid, centered in two (2) directions.
   12. Provide concealed sprinkler heads in 'public' areas such as corridors, student restrooms, commons, activity areas, locker rooms, etc. Apply paper cover to ensure concealed sprinkler head and cover plates do not receive field paint finish.
   13. Provide semi-recessed sprinkler heads at classrooms, office and other staff occupied spaces.
   14. Provide exposed sprinkler heads at all areas open to structure.
   15. Provide wire guards on heads in all mechanical rooms, gymnasiums, and other areas where heads are subject to damage.
   16. Sprinkler drop piping below ceiling configuration should be return bend (NFPA 13, Section 8.15.19) or flexible sprinkler drops shall be oriented such that the branch line connection is facing up.
   17. Arm-overs greater than 24 inches (609.6 mm) shall be supported.
   18. Install and connect fire pumps in accordance with Section 21 30 00 and NFPA 13.

19. Locate Fire Department Connection with sufficient clearance from walls, obstructions, or adjacent Siamese connectors to allow full swing of Fire Department wrench handle.
20. Inspector's test valves shall be installed for each sprinkler control valve assembly equipped with a flow switch and piped to an acceptable location as defined below. Design installation of inspector's test drain to accommodate the flow of discharge water under full flow conditions with pump running. The test drain is to be closed-pipe with a sight glass located to verify flow. Discharge piping to a remotely located sanitary drain, sump, or equivalent, in accordance with NFPA requirements and not requiring the addition of a hose to accommodate flow within the building. Locate test/drain valves and sight glasses inside stairwells, wherever practicable. Test drain shall not be piped to mop sinks.
21. All black steel piping shall be primed and painted red at factory/fabrication shop. Do not paint threads or fittings.

3.03 WELDED PIPING

A. Welding of pipe/fittings in normally occupied buildings is prohibited. Offsite welding is acceptable. Should welding be required in a normally occupied building for connecting to an existing welded system, obtain written approval from the Owner and comply with NFPA 51B.

B. All welding materials, procedures, qualifications and records shall comply with applicable NFPA requirements.

3.04 SYSTEM CLEANING AND FLUSHING

A. Cleaning, flushing and inspection shall be done in accordance with NFPA requirements.

B. The installing Contractor shall complete and sign the appropriate Contractor's Material and Test Certificates included within NFPA 13 and 14. Tests and signing of test certificates shall be witnessed by Owner's Construction Inspector or designee.

3.05 ZONING

A. All flow switches and tamper switches shall relay their activation to each annunciator panel and the main fire alarm panel.

B. Sprinkler system zoning shall coincide with building smoke compartmentalization unless noted otherwise on Contract Drawings. As a minimum, each floor level shall be a separate zone.

3.06 ACCEPTANCE TESTING

A. Pre-Acceptance Test: Prior to acceptance of the installation, subject the system to the test procedures as described by National Fire Protection Association Standards Nos. 13 and 24. Test pressures to be 200 psig (1378.95 kPa) minimum and are to be performed with all attached appurtenances. The duration of the test(s) to be a minimum of two (2) hours.

B. Acceptance Testing: AHJ requires 48 hours advance notice for this test. Upon completion of the installation, subject the system to the test procedures as described by National Fire Protection Association Standards Nos. 13 and 24 and provide the Owner with a Contractor's material and test certificate for aboveground or underground piping as required therein. Test pressures to be 200 psig (1378.95 kPa) minimum and are to be performed with all attached appurtenances. The duration of the test(s) to be a minimum of two (2) hours. Completely flush new piping system after completion of test. Prior to acceptance testing provide a set of complete shop drawings to verify installation.

3.07 SIGNAGE AND IDENTIFICATION POINTS

A. Install durable signage to indicate location of all shut-off and test valves. Locate signage in a commonly occupied/traveled location (e.g. hallway). Securely attach signage utilizing chains or other suitable methods. Provide signage with white letters and red background.

B. Install identification point signage for all hidden water flow switches. Identification tags to be white letters on a red background. Locate in areas visible from hallways.

3.08 TRAINING

A. Contractor shall provide for the service of a competent, trained and experienced agent to instruct and acquaint the Owner with the proper functioning, operation and maintenance of the fire protection systems and all installed components.

END OF SECTION

SECTION 22 13 01
SANITARY SEWERAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Buried sewer pipe and fittings.
B. Exposed and embedded soil, waste, drain, and vent piping.
C. Valves.
D. Floor drains.
E. Gutter and trench drains.
F. Battery room floor drains.
G. Cleanouts.
H. Piping specialties.
I. Flashings.
J. Escutcheons.
K. Neutralizing sumps.
L. Sewage ejectors.
M. Interceptors and tanks.

1.02 RELATED SECTIONS

A. Site sanitary sewerage system is specified in Section 33 31 00 - Sanitary Utility Sewerage Piping. Coordi-nate the work of this Section with the work of Section 33 31 00 - Sanitary Utility Sewerage Piping, as re-quired for a complete and finished sanitary sewerage system.

1.03 MEASUREMENT AND PAYMENT

A. Separate measurement or payment will not be made for the work required under this Section. All costs in connection with the Work specified herein will be considered to be included or incidental to the Work of this Contract.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM A48 Specification for Gray Iron Castings
   2. ASTM A74 Specification for Cast Iron Soil Pipe and Fittings
   3. ASTM D4021 Specification for Glass-Fiber-Reinforced Polyester Underground Petroleum Storage Tanks
   4. ASTM C4 Clay Drain Tile
   5. ASTM C14 Concrete Sewer, Storm Drain, and Culvert Pipe (ASTM C14M Concrete Sewer, Storm Drain, and Culvert Pipe [Metric]).
   6. ASTM C425 Compression Joints for Vitrified Clay Pipe and Fittings.
   7. ASTM C443 Joints for Circular Concrete Sewer and Culvert Pip, Using Rubber Gaskets (ASTM C443M – Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets [Metric}.
   8. ASTM C564 Rubber Gaskets for Cast iron Soil Pipe and Fittings.
   9. ASTM C700 Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
   10. ASTM C1053 Borosilicate Glass Pipe and fittings for Drain, Waste, and Vent (DWV) Applications.

11. ASTM D1785 Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
12. ASTM D2235 Solvent Cement for Acrylonitrile – Butadiene – Sryrene (ABS) Plastic Pipe and Fittings.
13. ASTM D2564 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
14. ASTM D2609 Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
15. ASTM D2661 Acrylonitrile – Butadiene – Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
16. ASTM D2662 Polybutylene (PB) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
17. ASTM D2665 Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
18. ASTM D2666 Polybutylene (PB) Plastic Tubing.
19. ASTM D2683 Socket-Type Polyethylene Fillings for Outside Diameter-Controlled Polyethylene Pipe.
20. ASTM D2729 Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
21. ASTM D2751 Acrylonitrile – Butadiene – Styrene (ABS) Sewer Pipe and Fittings.
22. ASTM D3034 Type PSM Poly (Vinyl Chloride) Sewer Pipe and Fittings.
23. CISPI 301 Coast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems
24. CISPI 310 Joints for Hubless Cast Iron Sanitary Systems.

B. Manufacturer’s Standardization Society of Valve and Fitting industry (MSS):
   1. MSS SP-70 Cast Iron Valves, Flanged and Threaded Ends
   2. MSS SP-80 Bronze Gate, Globe, Angle and Check Valve

1.05 SUBMITTALS

A. Data, and Samples, for submittal requirements and procedures.
B. Shop Drawings: Submit Shop Drawings showing piping layouts, sizes, types, valves, drains, cleanouts, sewage structure ejector station, and air compressor assembly.
C. Product Data: Submit manufacturers' product data for specified materials and equipment.
D. Operation and Maintenance Data: Submit equipment manufacturer's printed operating and maintenance in-structions in accordance with Section 01 78 23 - Operation and Maintenance Data, consisting of detailed parts list, recommended spare parts list, and complete operation and maintenance procedures.
E. Test Reports: Submit certified test reports of valves and equipment, as applicable.

1.06 SITE CONDITIONS

A. Excavations shall be dry immediately before and after products are installed. Provide surfaces and structures to, and on, which sewerage products will be installed capable of supporting the products. Complete construction, which will be concealed by sewerage products before sewerage products are installed.
B. Coordinate the installation of the sanitary sewerage system with other building systems and components so as to avoid conflicts of installation. Drawings are diagrammatic and not necessarily to scale. Do not scale drawings for exact locations of installation of pipelines, valves, and equipment.

PART 2 - PRODUCTS

2.01 BURIED SEWER PIPE AND FITTINGS

A. Piping below grade shall be Class H as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC.
B. Piping buried below slabs on grade and piping in the crawl space under platform slabs shall be cast iron sewer pipe, Class B, as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC, or ASTM A74 bell-and spigot cast iron sewer pipe with joints made tight and sealed in accordance with Engineer- approved shop details.
C. Ejector pump discharge lines shall be Class H as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC.
D. Acid waste, drainage, and vent piping shall be Class H pipe and fittings as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC.

2.02 EXPOSED AND EMBEDDED SOIL, WASTE, DRAIN, AND VENT PIPING

A. Provide Class B cast iron soil pipe and fittings as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC, for non-pressure piping.
B. Provide Class E copper tube as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC s, for HVAC condensate pan drain.
C. Provide Class C steel pipe and fittings as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC, for ejector pump discharge.

2.03 VALVES

A. General: Provide valves of types indicated.
B. Gate and Check Valves: Refer to Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC, for gate valves and swing check valves.
C. Backwater Valves: Provide backwater valves with cast iron bodies, hinged flaps, and seats, bolted covers, bronze trim, and flaps and seats removable through covers. Disc shall allow leakage, which will eliminate blocking of the valve by the bridging of solids on the upstream side. Flaps shall be sensitive to backflow, and capable of closing immediately upon backflow.
D. Trap Primer Unit: Provide automatic trap primer valve, copper or cast bronze, 150 psi operating pressure, solder joint ends, with internal air gap, in-line type, complete with distribution unit.

2.04 FLOOR DRAINS

A. Provide floor drains manufactured of heavy cast iron with double drainage flange, sediment bucket, integral seepage pan, trap primer connection, and clamping collar for waterproofing membrane.
B. Provide heel proof strainer of chromium-plated cast brass, polished brass or buff polished nickel alloy, as indicated, sized to match floor drain and attached to a bronze threaded collar for adjustment to varying floor thickness.
C. Provide cast-iron extra heavy traffic pattern floor drains where indicated.

2.05 GUTTER AND TRENCH DRAINS

A. Provide gutter and trench drains manufactured of heavy cast iron with sediment bucket, integral anchor flange and flashing clamp where membrane is provided. Provide cast iron, extra

heavy traffic pattern gutter trench drains, where indicated. Provide cast ductile iron anti-tilt grate unless otherwise indicated.

1. Coordinate with the requirements for trench drains specified in Section 05 50 00 - Metal Fabrications.

2.06 BATTERY ROOM FLOOR DRAIN

A. Cast iron body with acid resistant enameled interior and enamel coated dome strainer, bottom outlet with aperture joint to suit PVC pipe connection, heavy-duty, round flange flashing collar with weepholes.

2.07 CLEANOUTS

A. Provide cleanouts of cast iron conforming to ASTM A48, Class 25B and of sizes indicated.
B. Floor cleanouts shall be adjustable type, and shall have scoriated nickel alloy cover and, if for membrane waterproofed floors, a clamping device.
C. Wall cleanouts shall be bolted wedge type having a cover. Cover shall be satin stainless steel in flanged frame secured to plug with a vandal-proof screw.
D. Exposed cleanouts shall have raised brass head cleanout plug.
E. Grade cleanouts shall have adjustable sleeve-type housing, threaded brass plug with counter-sunk slot, and cast iron frame and cover.

2.08 PIPING SPECIALTIES

A. Gaskets for flanged joints shall be as specified in Section 20 10 13 - Common Materials and Methods for Facility Services – Fire Suppression, Plumbing and HVAC.
B. Couplings for connecting above ground and underground piping shall be specifically designed for the purpose required with transition type gaskets.

2.09 FLASHINGS

A. Provide either soft-tempered or cold-rolled copper, weighing not less than 16 ounces per square foot, or sheet lead, weighing not less than four pounds per square foot.

2.10 ESCUTCHEONS

A. Provide as specified in Section 20 20 13 - Pipe Sleeves, Supports and Anchors for Facility Services

2.11 NEUTRALIZING SUMPS

A. Provide sump molded in one piece from polyethylene with NPT connections and having minimum capacity of 15 gallons or 1.33 cubic feet of usable volume.
B. The sump shall be completely filled with marble chips, and furnished complete with gasketed, bolted

2.12 SEWAGE EJECTOR

A. Provide in accordance with Section 22 14 29 - Sump Pumps.

2.13 INTERCEPTORS AND TANKS

A. Interceptors:
   1. Interceptors shall be of epoxy-coated, cathodic-protected, steel of double wall construction with hydrostatic or dry well leak detector in annulus or waterproofed concrete with minimum of two compartments. Provide three 24-inch minimum diameter manholes with removable covers designed for TXDOT's H 20 traffic loads.
   2. Provide floating type light oil and fuel skimmer in each interceptor with gravity drain to waste oil tank; 3 inches diameter minimum; 1/2 inch per foot slope. Skimmer buoyancy shall be adjustable to allow skimming 0.90 to 0.94 specific gravity floating material.
   3. The manholes shall be located at interceptor ends for access to each compartment and centered over compartment partition for access to skimmer. Provide a plumbing vent terminating minimum of 10 feet above grade for each interceptor.
   4. The leak detector for double wall steel interceptors shall be located in the Mechanical or Electrical Room, as applicable, and a leak alarm shall be transmitted to Central as indicated on the Contract Drawings.

B. Tanks:
   1. Tanks shall be of glass fiber-reinforced polyester plastic conforming with ASTM D4021. Tanks shall be equipped with 22 inches minimum inside diameter manway with bolted and gasketed cover, 36 inches minimum diameter by 36 inches minimum high compartment above, and 24 inches diameter heavy duty traffic pattern manhole cover at grade.
   2. Tanks shall be furnished complete with 2 inches vent, terminating a minimum 10 feet above grade; 3 inches capped pump out connection with spill containment box with traffic pattern cover at grade, and level gage with remote dial indicator and high level alarm installed in the Mechanical or Electrical Room, as applicable. Tanks shall be of double wall construction with hydrostatic type leak detector or enclosed in concrete vault with floor mounted moisture type detector.
   3. The leak detection panel, level gage, and high level alarm shall be located in the Mechanical or Electrical Room, as applicable, and alarms shall be transmitted to Central as indicated on the Contract Drawings.

PART 3 - EXECUTION

3.01 PREPARATION

A. Excavations shall be free of water and extraneous material immediately before sanitary sewerage products are installed or placed. Bottoms of trenches shall have a 6 inch sand bed and shall be formed to support the bottom quadrant of the pipe and fittings. Should rock be encountered or should bedding material be unsuitable to support the products at indicated elevation, continue excavation to an elevation 8 inches below the indicated elevation and backfill with clean sand to the indicated elevation.

B. Interior of pipe, pipe fittings, valves, drains, and cleanouts shall be cleaned of dirt and foreign substances before installation.

C. Install sleeves through walls, floors, roofs, and other structures before sewerage lines are installed. Piping shall not be installed under walls, foundations, or footings. Invert of sleeves shall be minimum 6 inches above the bottom of footings and foundations.

3.02 INSTALLATION

A. Excavating and backfilling, including bedding and compacting requirements, shall conform to Section 33 05 28 - Trenching and Backfilling for Utilities.

B. Install products where indicated. Remove and reinstall products that are disturbed after installation. Ends of products to which future connections will be made shall be valved, plugged, or capped, and anchored.
C. Connections to existing facilities shall be made with fittings and short bends to suit the actual conditions; connect products in accordance with the product manufacturer's printed installation instructions.
D. Pipe and fittings shall be set true to line and grade before joints are made up. Angular deflections of joints shall not exceed the recommendations of the pipe and fitting manufacturer. Should the alignment require deflection of joints to be in excess of those recommended, use special bends to achieve the indicated deflection. Pipe ends and joints shall be prepared in accordance with the manufacturer's recommendations. As a minimum pipe ends shall be sanded and cleaned, fittings shall be cleaned, and solvent shall be applied to both pipe and fittings.
E. Slope horizontal soil and waste pipes a minimum 2% downward in direction of flow. Extend main vertical soil and waste stacks full size to the roof-line and above as vents, except where otherwise specifically indicated. Run vent pipes in roof spaces as close as possible to the underside of the roof without forming traps in pipe, using fittings as required. If a circuit vent pipe from fixture, or line of fixtures, will be connected to a vent line serving other fixtures, the connection shall be at least 6 inches above the flood- level of the highest fixture served. Grade and connect vent and branch-vent pipes to drip back to the vertical stack by gravity. Support all above grade piping in accordance with 15065, Pipe Sleeves, Supports, and Anchors.
F. Install wall sleeves and seals in accordance with 15065, Pipe Sleeves, Supports, and Anchors. Sealing members shall be installed so as to provide electrical isolation between the metallic carrier pipe and all metallic components of the sleeve and seal.
G. Make changes in pipe size on soil, waste, and drain lines with reducing fittings. Changes in direction shall be with either 45-degree wyes long or short-sweep 1/4, 1/6, 1/8 or 1/16 bends, or elbows.
H. Slip joints will be permitted only in fixture trap seals on the inlet side of the traps.
I. Installation of pipe and fittings shall comply with the manufacturers' recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted.
J. Joints in no hub cast iron soil pipe and fittings shall use double-seal, compression-type molded neoprene gasket, which shall provide a positive seal.
K. Tighten band and screw assemblies used in conjunction with hubless type cast iron pipe to 60-inch pounds torque on each band screw, with a torque wrench specifically designed for the purpose.
L. Provide escutcheons at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls, and ceilings. Fasten escutcheons to pipe or pipe covering.
M. Equip each fixture and piece of equipment connecting to the sanitary sewer system with a drain trap located as near fixture as possible, and no fixture shall be double-trapped.
N. Provide acid-proof piping in locations indicated. Install acid-proof piping separate from other waste piping, and connect to neutralizing sump, then to other sanitary piping only at mains.
O. Drains:
    1. Floor drain rim elevation shall be located such that uniform slope of 1-1/2 percent is maintained from the furthest distance at the perimeter of slab to rim. There shall be no local depression.
    2. Unless otherwise indicated, floor, shower, and trench drains connected to sanitary sewers shall be trapped.
    3. All below grade traps in public restrooms shall be provided with trap primers.
    4. Maintain integrity of waterproof membranes where penetrated by installing flashing collar or flange so that no leakage occurs between drain and adjoining materials.
    5. Position drains and neutralizing sumps so that they are readily accessible and easy to maintain.
P. Provide access panels in accordance with Section 20 10 13 - Common Materials and Methods

for Facility Services – Fire Suppression, Plumbing and HVAC.

Q. Interceptor and Tank Installation: Manhole covers shall be set with frame in reinforced concrete collar 48 inches minimum wide by 6 inches thick with No. 4 reinforcement 12 inches each way and finished flush with grade. Storage tanks shall be installed with antiflotation slab and tie downs in accordance with the manufacturer's instructions. Interceptors shall be installed on redwood sleepers or antiflotation slab in accordance manufacturer's instructions. Both storage tanks and interceptors shall have compacted pea gravel backfill installed to grade in accordance with the manufacturer's instructions.

3.03 PIPE CLEANOUTS

A. Cleanouts shall be the same size as the pipe up to and including 4 inches; for 6 inch and larger pipe, cleanouts shall be 4-inch minimum. Cleanouts for drainage pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place indicated. Wall or accessible piping cleanouts shall be T-pattern, 90-degree branch drainage fittings having screw plugs. Cleanouts shall be provided at the base of each riser and shall consist of a wye pattern fitting with a screw plug.

3.04 IDENTIFICATION

A. Identification shall be as specified in Section 20 40 13 - Identification for Facility Services.

3.05 FIELD QUALITY CONTROL

A. Do not cover products to be buried and do not paint products or line segments to be painted until those products have been inspected, tested, and accepted.

B. Test installed sewerage lines and equipment, with the Engineer in attendance, as follows:
   1. Fill gravity sewers and soil pipe with water and allow to stand for not less than 30 minutes without leaking; low and intermediate branches shall have been temporarily sealed. Provide test tees having cast iron screwed plugs in the vertical stacks if the sewers and soil pipe are to be tested in sections. Accomplish testing of interior lines before lines are concealed. Repair leaks and retest systems until the system exhibits no leaks. Head of water shall be not less than 5 feet, and shall not exceed 10 feet.
   2. Disconnect force mains from equipment, seal open ends, and fill mains with water, and hydrostatically test to a pressure of 50 psi greater than the normal pumping pressure. Maintain test pressure until the force main system has been examined for leaks. Repair leaks and retest system until no leaks are exhibited. Use testing instruments calibrated by a qualified laboratory in accordance with Section 01 45 00 - Quality Control.
   3. Test equipment by operation and adjustment of controls. Faulty equipment or controls shall be either repaired or replaced.

3.06 PAINTING

A. Except where indicated, piping systems shall not be painted. Where pipes are indicated to be painted, as exposed piping in finished rooms, prepare pipe and paint in accordance with Section 09 91 00 - Painting.

3.07 CLEANING

A. Cleaning of installed products shall consist of removing dirt and foreign material from the surfaces of products. Manufacturer's labels shall remain intact. Rust stained products shall either be replaced or recoated with paint, which is compatible with factory-applied coating.

3.08 REPAIR

A. Repair pipe coatings, which have become damaged during installation of pipe. Rust stained cast iron pipe and fittings shall either be replaced or recoated with paint, which is compatible with factory-applied coating.

END OF SECTION 22 13 01

SECTION 220500
COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Coordinate with Commissioning Requirements indicated in Section 019100. This contractor is responsible to comply with all requirements for the above section.

1.02 PLUMBING SYSTEM CRITERIA

A. Gas piping on roofs shall be supported by manufactured free standing pipe supports.

B. Water and gas lines under drives and walkways shall be sleeved with schedule to PVC, at least two pipe sizes larger than the supply line.

C. The design of the roof drainage systems shall incorporate roof drains and overflows. The overflow system shall be piped independently and connected vertically to the roof drain down spout. The overflows shall be located in locations readily visible. (*Discharge overflow above grade if required by local Authority having jurisdiction).

1.03 SUMMARY

A. Design a complete plumbing system including all sanitary, waste and vent piping, storm piping, gas piping and all equipment necessary for a complete system and in accordance with all local jurisdictions and codes.

B. All materials and distribution, and utilization equipment shall be UL Listed.

C. All equipment and materials shall be new, unused and of United States Domestic manufacture.

D. Provide hot and cold and tempered water isolation valves at every supply pipe to each restroom or restroom bank.

E. Isolation valves shall be accessible in all restrooms. The contractor shall provide a minimum of 2 feet (60.96 cm) accessible pipe chase for maintenance.

F. All cleanouts shall be accessible. Any room that has a plumbing fixture shall have an accessible isolation valve.

G. A record shall be kept of all permits and inspections and submitted to the Master Plumber. In addition, a list of all equipment and devices will be provided.

H. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Mechanical sleeve seals.
   5. Sleeves.
   6. Escutcheons.
   7. Grout.
   8. Equipment installation requirements common to equipment sections.
   9. Painting and finishing.
   10. Concrete bases.
   11. Supports and anchorages.

I. Related Sections:
   1. Section 013300 Submittals.
   2. Section 01524 Construction Waste Management
   3. Section 01352 LEED Requirements

4. Section 01611 Environmental Management
5. Section 01570 Pollution Prevention and Control

1.04 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   1. ABS: Acrylonitrile-butadiene-styrene plastic.
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PE: Polyethylene plastic.
   4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.05 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).

B. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2021.

C. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).

D. ASTM B32 - Standard Specification for Solder Metal; 2020.

E. ASTM B813 - Standard Specification for Water Flushable Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2024.

F. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.

G. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.

H. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings; 2022.

I. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020 (Reapproved 2024).

J. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings; 2007 (Reapproved 2023).

K. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings; 2024.

L. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems; 2024.

M. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020 (Reapproved 2024).

N. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals; 2019 (Reapproved 2025).

O. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings; 2026.

P. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2022 (Reapproved 2026).

Q. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2025.

R. AWWA C219 - Bolted Sleeve-Type Couplings for Plain-End Pipe; 2023.

1.06 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

C. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
   1. Recycled Content:
      a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
   2. Local/Regional Materials:
      a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
      b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
   3. VOC data:
      a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal’s Standard GS-11.
      b. Submit manufacturer’s certification that products comply with Green Seal’s Standard GS-11
      c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
   4. Submit the following according to Conditions of the Construction Contract.
      a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
   5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
   6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.07 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.09 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 PRODUCTS

2.01 ENVIRONMENTALLY PREFERABLE PRODUCTS

A. Provide environmentally preferable products to the greatest extent possible.
   1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.

B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.

C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.02 RECYCLED CONTENT

A. Provide recycled content products to the greatest extent possible.
   1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.03 REGIONAL MATERIALS

A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
   1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles (804.67 kilometers) from the project site.
      a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
   2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles (804.67 kilometers) of the project site.

2.04 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.05 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.06 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch (3.18 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:
   1. ABS Piping: ASTM D2235.
   2. CPVC Piping: ASTM F493.
   3. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
   4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.07 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Dresser Industries, Inc.; DMD Div.
      c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
      d. JCM Industries.
      e. Smith-Blair, Inc.
      f. Viking Johnson.
   2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
   3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.

4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. Eslon Thermoplastics.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. Thompson Plastics, Inc.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC PVC CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
   1. Manufacturers:
      a. NIBCO INC.
      b. NIBCO, Inc.; Chemtrol Div.

E. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Fernco, Inc.
      c. Mission Rubber Company.
      d. Plastic Oddities, Inc.

2.08 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F

D. Coordinate subparagraph and associated subparagraphs below with Part 2 "Manufacturers" Article. Retain "Available" for nonproprietary and delete for semiproprietary specifications.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Eclipse, Inc.
      d. Epco Sales, Inc.
      e. Hart Industries, International, Inc.
      f. Watts Industries, Inc.; Water Products Div.
      g. Zurn Industries, Inc.; Wilkins Div.

E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Epco Sales, Inc.
      d. Watts Industries, Inc.; Water Products Div.

F. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.
2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F
   1. Manufacturers:
      a. Calpico, Inc.
      b. Lochinvar Corp.

H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
   1. Manufacturers:
      a. Perfection Corp.
      b. Precision Plumbing Products, Inc.
      c. Sioux Chief Manufacturing Co., Inc.
      d. Victaulic Co. of America.

2.09 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Carbon steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.10 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Under-deck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.11 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.12 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type with spring clips.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
h. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
i. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
j. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
1. Cut sleeves to length for mounting flush with both surfaces.
a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50.8 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50.8 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
1) Seal space outside of sleeve fittings with grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches (152.4 mm) in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches (152.4 mm) and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.02 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 Appendixes.
   3. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
   4. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
   5. PVC Nonpressure Piping: Join according to ASTM D2855.
   6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.

K. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.

2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.03 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.04 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.05 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.06 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
1. Construct concrete bases of dimensions indicated, but not less than 4 inches (101.6 mm) larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.08 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.09 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

SECTION 220523
BALL VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Brass ball valves.
   2. Bronze ball valves.

1.03 DEFINITIONS

A. CWP: Cold working pressure

1.04 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2026.

C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.

D. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves; 2022, with Errata (2023).

E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.

F. ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2025.

G. ASME B31.9 - Building Services Piping; 2025.

H. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications; 2022.

I. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

J. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum

K. NSF 372 - Drinking Water System Components - Lead Content; 2024.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of valve.
   1. Certification that products comply with NSF 61and NSF 372.

1.06 SUBMITTALS

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and soldered ends.
   3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.5 for flanges on steel valves.
   4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   5. ASME B16.18 for solder-joint connections.
   6. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
   2. Hand lever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:
   1. Include 2-inch stem extensions.
   2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
   3. Memory stops that are fully adjustable after insulation is applied.

2.02 BRASS BALL VALVES

A. Brass Ball Valves, One-Piece:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. KITZ Corporation.
      b. WATTS.
   2. Description:
      a. Standard: MSS SP-110.
      b. CWP Rating: 400 psig (2757.90 kPa).
      c. Body Design: One piece.
      d. Body Material: Forged brass or bronze.
      e. Ends: Threaded and soldered.
      f. Seats: PTFE.
      g. Stem: Brass or stainless steel.
      h. Ball: Chrome-plated brass or stainless steel.
      i. Port: Reduced.

B. Brass Ball Valves, Two-Piece with Full Port and Brass Trim, Threaded or Soldered Ends:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Valve, Inc.
      b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      c. Center Line; a Crane Co. brand.
      d. Hammond Valve.

e. Jenkins Valves; a Crane Co. brand.
f. KITZ Corporation.
g. Milwaukee Valve Company.
h. Stockham; a Crane Co. brand.
i. WATTS.

2. Description:
a. Standard: MSS SP-110 or MSS SP-145.
b. CWP Rating: 600 psig (4136.86 kPa).
c. Body Design: Two piece.
d. Body Material: Forged brass.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Brass.
h. Ball: Chrome-plated brass.
i. Port: Full.

C. Brass Ball Valves, Two-Piece with Regular Port and Brass Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Center Line; a Crane Co. brand.
c. Hammond Valve.
d. KITZ Corporation.
e. Milwaukee Valve Company.
f. Red-White Valve Corp.
g. Stockham; a Crane Co. brand.
h. WATTS.

2. Description:
a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4136.86 kPa).
c. Body Design: Two piece.
d. Body Material: Forged brass.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Brass.
h. Ball: Chrome-plated brass.
i. Port: Regular.

2.03 BRONZE BALL VALVES

A. Bronze Ball Valves, One-Piece with Bronze Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. NIBCO INC.
b. WATTS.

2. Description:
a. Standard: MSS SP-110.
b. CWP Rating: 400 psig (2757.90 kPa).
c. Body Design: One piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Bronze.

h. Ball: Chrome-plated brass.
i. Port: Reduced.

B. Bronze Ball Valves, One-Piece with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. NIBCO INC.
b. WATTS.
2. Description:
a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4136.86 kPa).
c. Body Design: One piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Reduced.

C. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim, Threaded or Soldered Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Center Line; a Crane Co. brand.
c. Hammond Valve.
d. Jenkins Valves; a Crane Co. brand.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Red-White Valve Corp.
h. Stockham; a Crane Co. brand.
i. WATTS.
j. Zurn Industries, LLC.
2. Description:
a. Standard: MSS SP-110 or MSS-145.
b. CWP Rating: 600 psig (4136.86 kPa).
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Bronze or brass.
h. Ball: Chrome-plated brass.
i. Port: Full.

D. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim, Press Ends:
1. Press-end connections are not suitable for flammable gas service.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Center Line; a Crane Co. brand.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Red-White Valve Corp.

g. Stockham; a Crane Co. brand.
h. Viega LLC.

3. Description:
   a. Standard: MSS SP-110 or MSS-145.
   b. CWP Rating: Minimum 200 psig (1378.95 kPa).
   c. Body Design: Two piece.
   d. Body Material: Bronze.
   e. Ends: Press.
   f. Press Ends Connections Rating: Minimum 200 psig (1378.95 kPa).
   g. Seats: PTFE or RTPFE.
   h. Stem: Bronze or brass.
   i. Ball: Chrome-plated brass.
   j. Port: Full.
   k. O-Ring Seal: EPDM or Buna-N.

E. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      b. Center Line; a Crane Co. brand.
      c. DynaQuip Controls.
      d. Hammond Valve.
      e. Jenkins Valves; a Crane Co. brand.
      f. Milwaukee Valve Company.
      g. NIBCO INC.
      h. Red-White Valve Corp.
      i. Stockham; a Crane Co. brand.
      j. Viega LLC.
      k. WATTS.
   2. Description:
      a. Standard: MSS SP-110 or MSS-145.
      b. CWP Rating: 600 psig (4136.86 kPa).
      c. Body Design: Two piece.
      d. Body Material: Bronze.
      e. Ends: Threaded or soldered.
      f. Seats: PTFE.
      g. Stem: Stainless steel.
      h. Ball: Stainless steel, vented.
      i. Port: Full.

F. Bronze Ball Valves, Two-Piece with Regular Port and Bronze or Brass Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Valve, Inc.
      b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      c. Center Line; a Crane Co. brand.
      d. DynaQuip Controls.
      e. Hammond Valve.
      f. Jenkins Valves; a Crane Co. brand.
      g. Lance Valves.
      h. Milwaukee Valve Company.
      i. NIBCO INC.
      j. Red-White Valve Corp.

k. Stockham; a Crane Co. brand.
l. Viega LLC.

2. Description:
a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4136.86 kPa).
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Bronze or brass.
h. Ball: Chrome-plated brass.
i. Port: Regular.

G. Bronze Ball Valves, Two-Piece with Regular Port and Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Center Line; a Crane Co. brand.
c. DynaQuip Controls.
d. Hammond Valve.
e. Jenkins Valves; a Crane Co. brand.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corp.
i. Stockham; a Crane Co. brand.
j. Viega LLC.

2. Description:
a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4136.86 kPa).
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Regular.

H. Bronze Ball Valves, Three-Piece with Regular Port and Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. NIBCO INC.

2. Description:
a. Standard: MSS SP-110.
b. CWP Rating: 600 psig (4136.86 kPa).
c. Body Design: Three piece.
d. Body Material: Bronze.
e. Ends: Threaded or soldered.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Regular.

I. Bronze Ball Valves, Two-Piece, Safety-Exhaust:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      b. DynaQuip Controls.
      c. Lance Valves.
   2. Description:
      a. Standard: MSS SP-110.
      b. CWP Rating: 600 psig (4136.86 kPa).
      c. Body Design: Two piece.
      d. Body Material: Bronze, ASTM B584, Alloy C844.
      e. Ends: Threaded.
      f. Seats: PTFE.
      g. Stem: Stainless steel.
      h. Ball: Chrome-plated brass, with exhaust vent opening for pneumatic applications.
      i. Port: Full.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:
   1. Press-end connections are not for use with flammable gases. Press-end connections are limited to 200 psig (1378.95 kPa).
   2. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   4. For Copper Tubing, NPS 5 and Larger: Flanged ends.

5. For Steel Piping, NPS 2 and Smaller: Threaded ends.
6. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
7. For Steel Piping, NPS and Larger: Flanged ends.

3.04 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Brass ball valve, one piece. Provide with threaded or solder-joint ends.
   2. Bronze ball valve, one piece with stainless steel trim. Provide with threaded solder-joint ends.
   3. Brass ball valves, two-piece with full port and stainless-steel trim. Provide with solder -joint ends.

B. Pipe NPS 2-1/2 and Larger:
   1. Steel and Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Steel ball valves, Class 150 with full port.
   3. Iron ball valves, Class 150.

END OF SECTION

SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASME B31.9 - Building Services Piping; 2025.

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2026.

D. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.

E. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

G. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2026.

H. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).

I. MFMA-4 - Metal Framing Standards Publication; 2004.

J. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

K. SSPC-PA 1 - Shop, Field, and Maintenance Coating of Metals; 2024, with Errata (2025).

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal hanger-shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Equipment supports.

B. Related Requirements:
   1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers.
   2. Metal framing systems.
   3. Fiberglass strut systems.
   4. Pipe stands.

5. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers.
   2. Include design calculations for designing trapeze hangers.

1.05 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.06 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.02 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.
   3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless-steel material.

C. Copper Pipe and Tube Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel material.

2.03 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.04 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABB, Electrification Products Division.
      b. B-line; Eaton, Electrical Sector.
      c. Flex-Strut Inc.
      d. G-Strut.
      e. Haydon Corporation.
      f. Unistrut; Atkore International.
      g. Wesanco, Inc.
   2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
   3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
   4. Channels: Continuous slotted carbon-steel channel with interned lips.
   5. Channel Width: Selected for applicable load criteria.
   6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
   8. Metallic Coating: Electroplated zinc or Hot-dip galvanized.
   9. Plastic Coating: PVC.

2.05 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
      c. MKT Fastening, LLC.
      d. Simpson Strong-Tie Co., Inc.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. B-line; Eaton, Electrical Sector.
      b. Empire Tool and Manufacturing Co., Inc.
      c. Hilti, Inc.
      d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
      e. MKT Fastening, LLC.
   2. Indoor Applications: Zinc-coated steel.
   3. Outdoor Applications: Stainless steel.

2.06 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand:
   1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Hardware: Galvanized steel or polycarbonate.
4. Accessories: Protection pads.

C. Low-Profile, Single-Base, Single-Pipe Stand:
1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Vertical Members: Two galvanized-steel, continuous-thread, 1/2-inch rods.
4. Horizontal Member: Adjustable horizontal, galvanized-steel pipe support channels.
5. Pipe Supports: Strut clamps.
6. Hardware: Stainless steel.
7. Accessories: Protection pads.
8. Height: 18 inches (457.2 mm) above roof.

D. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.07 PIPE-POSITIONING SYSTEMS

A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.08 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.09 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Non-staining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.01 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.02 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (101.6 mm) thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

D. Pipe Stand Installation:
1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

E. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:
1. Attach clamps and spacers to piping.
    a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches (304.8 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4: 12 inches (304.8 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6: 18 inches (457.2 mm) long and 0.06 inch (1.52 mm) thick.

3.03 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

B. Fit exposed connections together to form hairline joints. Field weld connections cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.05 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (38 mm).

3.06 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils 0 inch (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.07 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal hanger-shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches (101.6 mm) of insulation.
   3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
   4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
   6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
   7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
   8. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches (152.4 mm) for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
   4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
   5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
   3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

R. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2026.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Stencils.
   5. Valve tags.
   6. Warning tags.

1.04 RELATED SECTIONS:

A. Section 013300 Submittals.

B. Section 01524 Construction Waste Management

C. Section 01352 LEED Requirements

D. Section 01611 Environmental Management

E. Section 01570 Pollution Prevention and Control

1.05 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

F. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
   1. Recycled Content:
      a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
   2. Local/Regional Materials:
      a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
      b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
   3. VOC data:
      a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal’s Standard GS-11.

b. Submit manufacturer's certification that products comply with Green Seal's Standard GS-11
c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.

4. Submit the following according to Conditions of the Construction Contract.
   a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.06 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 ENVIRONMENTALLY PREFERABLE PRODUCTS

A. Provide environmentally preferable products to the greatest extent possible.
   1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.

B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.

C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.02 RECYCLED CONTENT

A. Provide recycled content products to the greatest extent possible.
   1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.03 REGIONAL MATERIALS

A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
   1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles (804.67 kilometers) from the project site.
      a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
   2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles (804.67 kilometers) of the project site.

2.04 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (19.05 mm).
3. Minimum Letter Size: 1/4 inch (6.35 mm) for name of units if viewing distance is less than 24 inches (609.6 mm), 1/2 inch (12.7 mm) for viewing distances up to 72 inches (1828.8 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.18 mm) thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (19.05 mm).
6. Minimum Letter Size: 1/4 inch (6.35 mm) for name of units if viewing distance is less than 24 inches (609.6 mm), 1/2 inch (12.7 mm) for viewing distances up to 72 inches (1828.8 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.05 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.18 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (19.05 mm).

F. Minimum Letter Size: 1/4 inch (6.35 mm) for name of units if viewing distance is less than 24 inches (609.6 mm), 1/2 inch (12.7 mm) for viewing distances up to 72 inches (1828.8 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.06 PIPE LABELS

A. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

C. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.07 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch (19.05 mm) for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Fiberboard or metal.
   2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.08 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
   1. Tag Material: Brass, 0.032-inch Stainless steel, 0.025-inch Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook wire-link chain beaded chain S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

2.09 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: 3 by 5-1/4 inches (133 mm) minimum.
   2. Fasteners: Reinforced grommet and wire or string.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulates.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09.

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels color-coded bands or rectangles complying with ASME A13.1 on each piping system.
   1. Identification Paint: Use for contrasting background.
   2. Stencil Paint: Use for pipe marking.

C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet (1524 cm) along each run. Reduce intervals to 25 feet (762 cm) in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Pipe Label Color Schedule:
   1. Domestic Water Piping:
      a. Background Color: Blue.
      b. Letter Color: Black.
   2. Sanitary Waste and Storm Drainage Piping:
      a. Background Color: Blue.
      b. Letter Color: White.

3.04 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Other valve-tag sizes, shapes, colors, and letter colors may be available if required.
   2. Valve-Tag Size and Shape:
      a. Cold Water: 1-1/2 inches (38 mm), round.
      b. Hot Water: 1-1/2 inches (38 mm), round.
      c. Low-Pressure Compressed Air: 1-1/2 inches (38 mm), round.
   3. Select contrasting valve-tag color and letter color in two subparagraphs below for each service. Retain "Natural" option for brass or stainless-steel valve tags.
   4. Valve-Tag Color:
      a. Cold Water: Natural.
      b. Hot Water: Natural.
   5. Letter Color:
      a. Cold Water: Black.

b. Hot Water: Black.

3.05 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 220593
TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. TAB of domestic water system.
   2. TAB of plumbing equipment
   3. Pipe-leakage test verification.
   4. Testing, adjusting, and balancing of existing plumbing systems and equipment.

1.03 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.04 REFERENCE STANDARDS

A. NEBB (TAB) - Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems; 2026.

1.05 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 15 days' advance notice of scheduled meeting time and location.
   1. Minimum Agenda Items:
      a. The Contract Documents examination report.
      b. The TAB plan.
      c. Needs for coordination and cooperation of trades and subcontractors.
      d. Proposed procedures for documentation and communication flow.

1.06 INFORMATIONAL SUBMITTALS

A. Information submittals are submittals that require review by Architect, but they do not require Architect's responsive action and return of reviewed documents to Contractor, provided submittals comply with requirements. If rejected, submittals with responsive action must be returned to Contractor.

B. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

C. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

D. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, a s specified in "Preparation" Article.

E. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

F. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

G. Certified TAB reports.

H. Sample report forms.

I. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.07 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
   2. TAB Technician: Employee of the TAB specialist and certified by AABC.

B. TAB Specialists Qualifications, Certified by NEBB:
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB (TAB) Technician: Employee of the TAB specialist and certified by NEBB.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE 111 Compliance: Requirements in ASHRAE 111 applicable to analogous domestic water system and plumbing equipment balancing.

E. ASHRAE 188 Compliance: Comply with balancing and report requirements, Section 8.3 "Balancing."

F. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.08 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine approved submittals for plumbing systems and equipment.

D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.

E. Examine equipment performance data, including pump curves.

1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.

F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.

J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

K. Examine system pumps to ensure absence of entrained air in the suction piping.

L. Examine operating safety interlocks and controls on plumbing equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

A. Prepare a TAB plan that includes the following:
1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
1. Domestic Water System:
a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
b. Water heaters are installed and functioning.
c. Piping is complete and all points of outlet are installed.
d. Water treatment is complete.
e. Systems are flushed, filled, and air purged.
f. Strainers are clean.
g. Control valves are functioning in accordance with the sequence of operation.
h. Shutoff and balance valves are 100 percent open.
i. hot-water circulating pumps are operational and proper rotation is verified.
j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
k. Variable-frequency controllers' startup is complete and safeties are verified.
l. Suitable access to balancing devices and equipment is provided.
2. Sanitary Sewage/Drainage System:
a. Leakage and pressure tests on sanitary sewage/drainage systems have been completed in accordance with applicable code and authority having jurisdiction requirements.

b. Piping is complete.
c. Sanitary sewage pumps/drainage pumps are operational.
d. Control valves are functioning in accordance with the sequence of operation.
e. Shutoff valves are 100 percent open.
f. Suitable access to equipment is provided.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems"and in this Section.

B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
   1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
   2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 220719 "Plumbing Piping Insulation."

C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:
   1. Motors.
   2. Domestic water in-line pumps.
   3. Domestic water heaters.

3.05 PROCEDURES FOR DOMESTIC WATER SYSTEMS

A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:
   1. Check expansion tank for proper setting.
   2. Check water heater for proper discharge temperature setting.
   3. Check remotest point of outlet for adequate pressure.
   4. Check flow-control valves for proper position.
   5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
   6. Verify that motor controllers are equipped with properly sized thermal protection.
   7. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

G. Check settings and operation of each safety valve. Record settings.

3.06 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

A. Balance system with manual or automatic balancing valves by setting at design flow.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

B. Adjust pump to deliver total design flow.
1. Measure pump TDH as follows:
a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
3. Mark final settings and verify that all memory stops have been set.
4. Verify final system conditions as follows:
a. Re-measure and confirm that total flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
c. Mark final settings.

3.07 PROCEDURES FOR MOTORS

A. Motors ½ HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.08 PROCEDURES FOR WATER HEATERS

A. Electric Water Heaters:
1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. Measure and Record relief valve(s) pressure setting.
5. Capacity: Calculate in Btu/h (kW) of heating output.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

3.09 TOLERANCES

A. Set plumbing system's flow rates within the following tolerances:
1. Domestic Water Flow Rate: Plus or minus 10 percent. If design value is less than 10 gpm (0.63 L/s), within 10 percent.
2. Compressed-Air Flow Rate:[Plus 10 percent or minus 5 percent. If design value is less than 10 gpm within 10 percent.
3. Vacuum Flow Rate: Plus 10 percent or minus 5 percent.

3.10 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.11 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.
   3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Manufacturers' test data.
   3. Field test reports prepared by system and equipment installers.
   4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB specialist.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents, including the following:
      a. Indicated versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Notes to explain why certain final data in the body of reports vary from indicated values.
   14. Test conditions for pump performance forms, including the following:
      a. Variable-frequency controller settings for variable-flow hydronic systems.
      b. Settings for pressure controller(s).
      c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:
   1. Flow rates.
   2. Pipe and valve sizes and locations.

3. Balancing stations.
4. Position of balancing devices.

E. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
   1. Unit Data:
      a. System identification.
      b. Location.
      c. Model number and unit size.
      d. Manufacturer's serial number.
      e. Output capacity in Btu/h (kW).
      f. Number of stages.
      g. Connected volts, phase, and hertz.
      h. Rated amperage.
   2. Test Data (Indicated and Actual Values):
      a. Heat output in Btu/h (kW).
      b. Entering-water temperature in deg F.
      c. Leaving-water temperature in deg F.
      d. High-temperature-limit setting in deg F.
      e. Operating set point in deg F.
      f. Voltage at each connection.
      g. Amperage for each phase.

F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Service.
      d. Make and size.
      e. Model number and serial number.
      f. Water flow rate in gpm (L/s).
      g. Water-pressure differential in feet of head or psig (kPa).
      h. Required net positive suction head in feet of head or psig (kPa).
      i. Pump speed.
      j. Impeller diameter in inches (mm).
      k. Motor make and frame size.
      l. Motor horsepower and rpm.
      m. Voltage at each connection.
      n. Amperage for each phase.
      o. Full-load amperage and service factor.
      p. Seal type.
   2. Test Data (Indicated and Actual Values):
      a. Static head in feet of head or psig.
      b. Pump shutoff pressure in feet of head or psig.
      c. Actual impeller size in inches.
      d. Full-open flow rate in gpm.
      e. Full-open pressure in feet of head or psig.
      f. Final discharge pressure in feet of head or psig.
      g. Final suction pressure in feet of head or psig.
      h. Final total pressure in feet of head or psig.
      i. Final water flow rate in gpm.
      j. Voltage at each connection.

k. Amperage for each phase.

G. Instrument Calibration Reports:
1. Report Data:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.12 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager or Commissioning Authority.

B. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION

SECTION 220719
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2024).

B. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2024).

C. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging; 2018 (Reapproved 2026).

D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2026.

E. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2025.

F. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2022.

G. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2022.

H. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).

I. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation; 2024.

J. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation; 2023.

K. ASTM C1427 - Standard Specification for Extruded Preformed Flexible Cellular Polyolefin Thermal Insulation in Sheet and Tubular Form; 2025.

L. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds; 2025.

M. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

N. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

O. ASTM F1249 - Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor; 2025.

P. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. Section includes insulating the following plumbing piping services:
   1. Domestic cold-water piping.
   2. Domestic hot-water piping.
   3. Domestic recirculating hot-water piping.
   4. Sanitary waste piping exposed to freezing conditions.
   5. Storm-water piping exposed to freezing conditions.
   6. Roof drains and rainwater leaders.
   7. Supplies and drains for handicap-accessible lavatories and sinks.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Sustainable Design Submittals:

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at pipe expansion joints for each type of insulation.
   4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Detail removable insulation at piping specialties, equipment connections, and access panels.
   6. Detail application of field-applied jackets.
   7. Detail application at linkages of control devices.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
   1. Preformed Pipe Insulation Materials: 12 inches (304.8 mm) long by NPS 2.
   2. Jacket Materials for Pipe: 12 inches (304.8 mm) long by NPS 2.
   3. Sheet Jacket Materials: 12 inches (304.8 mm) square.
   4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less and smoke-developed index of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
   1. Piping Mockups:
      a. One 10-foot section of NPS 2 straight pipe.
      b. One each of a 90 degree threaded, welded, and flanged elbow.
      c. One each of a threaded, welded, and flanged tee fitting.

d. One NPS 2 or smaller valve and one NPS 2-1/2 or larger valve.
e. Four support hangers, including hanger shield and insert.
f. One threaded strainer and one flanged strainer with removable portion of insulation.
g. One threaded reducer and one welded reducer.
h. One pressure temperature tap.
i. One mechanical coupling.
j. One union.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

D. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.08 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.09 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Pittsburgh Corning Corporation.
   2. Preformed Pipe Insulation: Type II, Class 1, without jacket.
   3. Preformed Pipe Insulation: Type II, Class 2, with factory-applied ASJ jacket.
   4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
   5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Aeroflex USA.
      b. Armacell LLC.
      c. K-Flex USA.

H. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Johns Manville; a Berkshire Hathaway company.
      b. Knauf Insulation.
      c. Manson Insulation Inc.
      d. Owens Corning.
   2. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.
   3. 850 deg F.
   4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
   5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Phenolic: Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ITW Insulation Systems; Illinois Tool Works, Inc.
      b. Resolco Inc.
   2. Preformed Pipe Insulation: Type III with factory-applied ASJ.
   3. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
   4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C534/C534M or ASTM C1427, Type I, Grade 1, for tubular materials.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Armacell LLC.

2.02 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Ramco Insulation, Inc.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. Ramco Insulation, Inc.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. Ramco Insulation, Inc.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. Foster Brand; H. B. Fuller Construction Products.

C. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Aeroflex USA.
    b. Armacell LLC.
    c. Foster Brand; H. B. Fuller Construction Products.
    d. K-Flex USA.
2. Not all manufacturers comply with sustainability requirements. If sustainability is a Project goal, consult manufacturers.
3. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
4. Wet Flash Point: Below 0 deg F.
5. Service Temperature Range: 40 to 200 deg F.
6. Color: Black.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller Construction Products.

E. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller Construction Products.

F. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller Construction Products.
    c. Mon-Eco Industries, Inc.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Dow Consumer Solutions.
   b. Johns Manville; a Berkshire Hathaway company.
   c. P.I.C. Plastics, Inc.
   d. Speedline Corporation.

2.04 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller Construction Products.
      c. Knauf Insulation.
      d. Vimasco Corporation.
   2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
   3. Service Temperature Range: 0 to plus 180 deg F.
   4. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
   5. Color: White.

C. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller Construction Products.
      c. Mon-Eco Industries, Inc.
   2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
   3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
   4. Color: White.

D. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller Construction Products.
   2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
   3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
   4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller Construction Products.
      c. Knauf Insulation.
      d. Mon-Eco Industries, Inc.
      e. Vimasco Corporation.
   2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
   3. Service Temperature Range: 0 to plus 180 deg F.

4. Color: White.

2.05 LAGGING ADHESIVES

A. Adhesives shall comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller Construction Products.
      c. Vimasco Corporation.
   2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
   3. Service Temperature Range: 20 to plus 180 deg F.
   4. Color: White.

2.06 SEALANTS

A. Sealants are categorized into "joint sealants" and "flashing sealants." Joint sealants are primarily used for vapor-sealing longitudinal seams and butt joints of insulation materials. Flashing sealants are primarily used for sealing jacket and mastic materials.

B. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

C. Joint Sealants:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller Construction Products.
      c. Mon-Eco Industries, Inc.
      d. Pittsburgh Corning Corporation.
   2. Permanently flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 58 to plus 176 deg F.
   4. Color: White or gray.

D. FSK and Metal Jacket Flashing Sealants:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller Construction Products.
      c. Mon-Eco Industries, Inc.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   4. Color: Aluminum.

E. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Childers Brand; H. B. Fuller Construction Products.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   4. Color: White.

2.07 FACTORY-APPLIED JACKETS

A. Coordinate types of factory-applied jacket insulation materials selected and types of factory-applied jackets indicated in insulation system schedules.

B. For insulation materials with factory-applied jackets for use on applications of greater than 140 deg F (60 deg C), specify sufficient insulation thickness to maintain outer surface temperature of insulation below 140 deg F (60 deg C). 140 deg F (60 deg C) surface temperature is set by OSHA for personnel protection.

C. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.08 FIELD-APPLIED JACKETS

A. Insulation jackets in this article are for field application. ASTM C1136, Type I, is for use over insulation on pipes operating at below-ambient temperatures at least part of the time or where a vapor barrier is required. ASTM C1136, Type II, is for use over insulation on pipes operating above-ambient temperatures or where a vapor retarder is not required.

B. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.

C. A properly sealed FSK jacket, common with most forms of factory-applied jackets for mineral-fiber insulation, complies with vapor-retarder requirements of ASTM C1136, Type I.

D. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

E. Although other thicknesses for PVC jackets are available, a flame-spread index of 25 and a smoke-developed index of 50 apply only to thicknesses of 30 mils 0.03 inch (0.8 mm) and less.

F. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Johns Manville; a Berkshire Hathaway company.
      b. P.I.C. Plastics, Inc.
      c. Proto Corporation.
      d. Speedline Corporation.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. PVC jackets are available in several colors. Colored jackets may be used to replace field painting. UV rays fade colors in exterior applications. Some colors (black, gray, and white) do not fade as quickly as other colors (red, orange, and green). Colored jackets have different emissivity and are not recommended for outdoor use.
   4. Color: White.
   5. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

G. Metal Jacket:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ITW Insulation Systems; Illinois Tool Works, Inc.
      b. RPR Products, Inc.
   2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
      a. Factory cut and rolled to size.

b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.
e. Factory-Fabricated Fitting Covers:
    1) Same material, finish, and thickness as jacket.
    2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    3) Tee covers.
    4) Flange and union covers.
    5) End caps.
    6) Beveled collars.
    7) Valve covers.
    8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.09 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. 3M Industrial Adhesives and Tapes Division.
        b. Avery Dennison Corporation, Specialty Tapes Division.
        c. Ideal Tape Co., Inc., an American Biltrite Company.
        d. Knauf Insulation.
    2. Width: 3 inches (76.2 mm).
    3. Thickness: 11.5 mils (0.2921 mm).
    4. Adhesion: 90 ounces force/inch in width.
    5. Elongation: 2 percent.
    6. Tensile Strength: 40 lbf/inch in width.
    7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. 3M Industrial Adhesives and Tapes Division.
        b. Avery Dennison Corporation, Specialty Tapes Division.
        c. Ideal Tape Co., Inc., an American Biltrite Company.
        d. Knauf Insulation.
    2. Width: 3 inches (76.2 mm).
    3. Thickness: 6.5 mils (0.1651 mm).
    4. Adhesion: 90 ounces force/inch in width.
    5. Elongation: 2 percent.
    6. Tensile Strength: 40 lbf/inch in width.
    7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. 3M Industrial Adhesives and Tapes Division.
        b. Ideal Tape Co., Inc., an American Biltrite Company.
    2. Width: 2 inches (50.8 mm)

3. Thickness: 6 mils (0.1524 mm).
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. 3M Industrial Adhesives and Tapes Division.
   b. Avery Dennison Corporation, Specialty Tapes Division.
   c. Ideal Tape Co., Inc., an American Biltrite Company.
   d. Knauf Insulation.
2. Width: 2 inches (50.8 mm).
3. Thickness: 3.7 mils (0.09398 mm).
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils 0 inch (0.13 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range of between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
   3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches (101.6 mm) o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches (101.6 mm) o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (101.6 mm) beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50.8 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50.8 mm).
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50.8 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches (152.4 mm) o.c.

4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25.4 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.07 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as that of pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.08 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches (152.4 mm) o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25.4 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.09 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:
   1. Secure single-layer insulation with stainless steel bands at 12-inch intervals, and tighten bands without deforming insulation materials.
   2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches (76.2 mm). Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches (152.4 mm) o.c.
   4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as that of pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as that of pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of polyolefin pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.11 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches (304.8 mm) o.c. and at end joints.

3.12 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.13 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

F. See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

G. All insulation applications will be considered defective if they do not pass tests and inspections.

H. Prepare test and inspection reports.

3.14 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Underground piping.
   2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.15 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:
   1. NPS 1 and Smaller: Insulation shall be one of the following:
      a. Cellular Glass: 1-1/2 inches (38 mm) thick.
      b. Flexible Elastomeric: 1 inch (25.4 mm) thick.
      c. Phenolic: 1 inch (25.4 mm) thick.
   2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
      a. Cellular Glass: 1-1/2 inches (38 mm) thick.
      b. Flexible Elastomeric: 1 inch (25.4 mm) thick.
      c. Phenolic: 1 inch (25.4 mm) thick.

B. Domestic Hot and Recirculated Hot Water:
   1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
      a. Cellular Glass: 1-1/2 inches (38 mm) thick.
      b. Flexible Elastomeric: 1 inch (25.4 mm) thick.
   2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
      a. Cellular Glass: 1-1/2 inches (38 mm) thick.
      b. Flexible Elastomeric: 1 inch (25.4 mm) thick.

C. Stormwater and Overflow:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Cellular Glass: 1-1/2 inches (38 mm) thick.
      b. Flexible Elastomeric: 1 inch (25.4 mm) thick.

D. Roof Drain and Overflow Drain Bodies:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Cellular Glass: 1-1/2 inches (38 mm) thick.
      b. Flexible Elastomeric: 1 inch (25.4 mm) thick
      c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25.4 mm) thick.

E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 3/4 inch (19.05 mm) thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25.4 mm) thick.

F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet (3 m) ???Insert distance??? of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Cellular Glass: 1-1/2 inches (38 mm) thick.
      b. Flexible Elastomeric: 1 inch (25.4 mm) thick.

3.16 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 2 inches (50.8 mm) thick.
      b. Phenolic: 2 inches (50.8 mm) thick.

c. Polyolefin: 2 inches (50.8 mm) thick.

3.17 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. None.

D. Piping, Exposed:
   1. Aluminum, Smooth 0.020 inch (0.51 mm) thick.

3.18 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. Aluminum, Smooth 0.024 thick.
   2. Stainless Steel, Type 304 Smooth No. 2B Finish 0.024 inch (0.61 mm) thick.

D. Piping, Exposed:
   1. Stainless Steel, Type 316, Smooth No. 2B Finish with Z-Shaped Locking Seam: [0.010 inch (0.25 mm) 0.024 inch (0.61 mm) thick.

END OF SECTION

SECTION 221116
DOMESTIC WATER PIPING

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).

B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.

C. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2021.

D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.

E. ASME B16.24 - Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500; 2021.

F. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).

G. ASME B31.9 - Building Services Piping; 2025.

H. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).

I. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

J. ASTM A536 - Standard Specification for Ductile Iron Castings; 2026a.

K. ASTM A674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe; 2022.

L. ASTM B32 - Standard Specification for Solder Metal; 2020.

M. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.

N. ASTM B813 - Standard Specification for Water Flushable Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2024.

O. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.

P. AWWA C219 - Bolted Sleeve-Type Couplings for Plain-End Pipe; 2023.

Q. AWWA C606 - Grooved and Shouldered Joints; 2022.

R. AWWA C651 - Disinfecting Water Mains; 2023.

S. AWWA C652 - Disinfection of Water-Storage Facilities; 2025.

T. NSF 14 - Plastics Piping System Components and Related Materials; 2025.

U. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. Section Includes:
   1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
   2. Encasement for piping.
   3. Specialty valves.
   4. Flexible connectors.
   5. Water meters.
   6. Escutcheons.

7. Sleeves and sleeve seals.
8. Wall penetration systems.

B. Related Sections:
1. Section 013300 Submittals.
2. Section 01524 Construction Waste Management
3. Section 01352 LEED Requirements
4. Section 01611 Environmental Management
5. Section 01570 Pollution Prevention and Control

1.04 SUBMITTALS

A. Product Data: For the following products:
1. Specialty valves.
2. Transition fittings.
3. Dielectric fittings.
4. Flexible connectors.
5. Backflow preventers and vacuum breakers.
6. Escutcheons.
7. Sleeves and sleeve seals.
8. Water penetration systems.

B. Water Samples: Specified in "Cleaning" Article.

C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
1. Fire-suppression-water piping.
2. Domestic water piping.
3. Natural Gas piping.

D. Field quality-control reports.

E. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
1. Recycled Content:
a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
2. Local/Regional Materials:
a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
3. VOC data:
a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal’s Standard GS-11.
b. Submit manufacturer’s certification that products comply with Green Seal’s Standard GS-11
c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
4. Submit the following according to Conditions of the Construction Contract.
a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.

6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.05 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.

C. Comply with NSF 61 for potable domestic water piping and components.

1.06 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 PRODUCTS

2.01 ENVIRONMENTALLY PREFERABLE PRODUCTS

A. Provide environmentally preferable products to the greatest extent possible.
   1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.

B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.

C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.02 RECYCLED CONTENT

A. Provide recycled content products to the greatest extent possible.
   1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.03 REGIONAL MATERIALS

A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
   1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles (804.67 kilometers) from the project site.
      a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
   2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles (804.67 kilometers) of the project site.

2.04 WATER SUPPLY SYSTEM:

A. A complete system of hot and cold water supply to all plumbing fixtures and mechanical equipment shall be supplied and installed as shown on the Drawings. The water supply system shall be installed using the materials and methods as specified in the following paragraphs.

B. UNDERGROUND WATER PIPING SYSTEMS:
   1. Pipe: All pipe used for underground water piping mains shall be Class 52 centrifugally cast, close grained cast iron pipe or Class 50 DUCTILE iron pipe arranged with bell and spigot mechanical joints.
   2. Valve Boxes:
      a. For each underground valve installed by the Contractor, the Contractor shall provide and install a two-piece, screw adjustable type valve box. These valve boxes shall be

designed for heavy roadway service and they shall have a deep socket type of cover which prevents their being accidentally knocked out of position.

C. The word "WATER" shall appear on each cover. The installation of these members shall be such that by the use of the adjustable screw type bodies the tops are just flush with the finished grade. These valve boxes shall be Tyler Pipe Industries #6850, or approved equal.
   1. Lead: It is forbidden that lead in any form be used in any water system other than waste. If lead is used in the fabrication or installation of any water system other than waste, then ALL of the installed equipment and material, which may have come in contact with the lead, shall be marked with bright red or orange spray paint, and shall be removed from the project site. The system(s) shall then be restored and reinstalled using ALL NEW MATERIALS.

D. IRRIGATION PROVISIONS:
   1. Furnish and install capped and/or valved water lines under paving, through retaining walls in paved plaza areas and as indicated on Drawings for connections and extensions under work of Section Irrigation (Sprinkler) System.

E. BUILDING ENTRANCE:
   1. A metallic sleeve shall be inserted in the forms of the building wall through which the water service enters the building. The interior diameter of such sleeve shall be four inches (4") greater than the exterior diameter of the water service.
   2. The water service pipe from within the building shall be extended to a point five feet outside the building wall through this sleeve. The position of the water service in this sleeve shall be concentric and the intervening space shall be packed in a flexible manner to avert the flow of water from outside of the building into the basement.
   3. The interior pipe extended outside the building shall be provided with a protective wrapping of "Tape Coat" SP warmed with hand torch. This protective tape shall be applied with "half lap" coverage in strict accordance with the manufacturer's published instructions. The cast iron pipe connected to the pipe extending from the building wall shall contain two caulked joints within four feet of the union of the cast iron pipe and the interior pipe from the building.

2.05 REQUIREMENTS OF INTERIOR WATER PIPING SYSTEMS:

A. All piping shall have reducing fittings used for reducing or increasing where any change in the pipe sizes occurs. No bushing of any nature shall be allowed in piping.

B. All exposed chrome plated, polished or enameled connections from fixtures shall be put up with special care, showing no tool marks or threads at fittings, and supported by neat racks or hangers with round head screws of same material and finish.

C. Wade Shok-stop, or approved equal, sealed air chambers shall be provided in all water branches to fixtures, sized in accordance with manufacturer's recommendations, concealed, accessible, and located so as to protect each group of plumbing fixtures.

D. The fabrication of copper pipe and fittings shall in every detail conform to the recommendations and instructions of the fitting manufacturer. The tools used shall be the tools adapted to that specific purpose.

2.06 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B88, Type L water tube, drawn temper shall be used for all domestic cold, hot water and hot water return piping up to and including 4" for above grade applications.
   1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
   2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
   4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Interior domestic water piping of 6” and larger shall be schedule 40 galvanized steel to ASTM A53.

2.07 DUCTILE-IRON PIPE AND FITTINGS (FOR UNDERGROUND USE)

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
   2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.
      a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.
      a. Gaskets: AWWA C111, rubber.
   2. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.
      a. Gaskets: AWWA C111, rubber.

C. Plain-End, Ductile-Iron Pipe: AWWA C151.
   1. Grooved-Joint, Ductile-Iron-Pipe Appurtenances:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Anvil International.
         2) Shurjoint Piping Products.
         3) Star Pipe Products.
         4) Victaulic Company.
      b. Grooved-End, Ductile-Iron Fittings: ASTM A47/A47M, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions matching pipe.
      c. Grooved-End, Ductile-Iron-Pipe Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

2.08 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.18 mm) thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.09 SPECIALTY VALVES

A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.10 TRANSITION FITTINGS

A. General Requirements:
   1. Same size as pipes to be joined.
   2. Pressure rating at least equal to pipes to be joined.
   3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cascade Waterworks Manufacturing.
      b. Dresser, Inc.; Dresser Piping Specialties.
      c. Ford Meter Box Company, Inc. (The).
      d. JCM Industries.
      e. Romac Industries, Inc.
      f. Smith-Blair, Inc; a Sensus company.
      g. Viking Johnson; c/o Mueller Co.

D. Plastic-to-Metal Transition Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Charlotte Pipe and Foundry Company.
      b. Harvel Plastics, Inc.
      c. Spears Manufacturing Company.
   2. Description: CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket or threaded end.

2.11 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company.
      b. Central Plastics Company.
      c. EPCO Sales, Inc.
      d. Hart Industries International, Inc.
      e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      f. Zurn Plumbing Products Group; Wilkins Water Control Products.
   2. Description:
      a. Pressure Rating: 150 psig (1034.21 kPa) at 180 deg F.
      b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company.
      b. Central Plastics Company.
      c. EPCO Sales, Inc.
      d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Factory-fabricated, bolted, companion-flange assembly.
      b. Pressure Rating: 150 psig (1034.21 kPa).
      c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.
2. Description:
   a. Non-conducting materials for field assembly of companion flanges.
   b. Pressure Rating: 150 psig (1034.21 kPa).
   c. Gasket: Neoprene or phenolic.
   d. Bolt Sleeves: Phenolic or polyethylene.
   e. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Calpico, Inc.
   b. Lochinvar Corporation.
2. Description:
   a. Galvanized-steel coupling.
   b. Pressure Rating: 300 psig (2068.43 kPa) at 225 deg F.
   c. End Connections: Female threaded.
   d. Lining: Inert and noncorrosive, thermoplastic.

2.12 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber-Booth.
2. Triplex.
3. Mercer Rubber Co.
4. Metraflex, Inc.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
1. Working-Pressure Rating: Minimum 200 psig (1378.95 kPa).
2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
1. Working-Pressure Rating: Minimum 200 psig (1378.95 kPa).
2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.13 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. Split Casting, Cast Brass: Polished, chrome-plated or rough-brass finish with concealed hinge and setscrew.

C. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.14 SLEEVES

A. Galvanized-Steel-Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.

2.15 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex, Inc.
   4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.16 WALL PENETRATION SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. SIGMA.

B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
   1. Carrier-Pipe Deflection: Up to 5 percent without leakage.
   2. Housing: Ductile-iron casting with hub, water stop, anchor ring, and locking devices. Include gland, bolts, and nuts.
   3. Housing-to-Sleeve Gasket: EPDM rubber.
   4. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.
   5. Pipe Sleeve: ASTM A53/A53M, Schedule 40, zinc-coated steel pipe.

PART 3 EXECUTION

3.01 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Provide shut-off valve for each battery of fixtures located above ceiling near each bathroom.

C. All buried piping shall be buried a minimum of 30” below finished grade including domestic water.

D. Install underground ductile-iron pipe in PE encasement according to ASTM A674 or AWWA C105.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Valves 2-½” and smaller shall be cast brass with stainless steel ball and stem; 3” and larger shall be gate valves.

H. Butterfly valves are not acceptable for any plumbing applications.

I. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.

J. Install domestic water piping level and plumb.

K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

M. Install piping adjacent to equipment and specialties to allow service and maintenance.

N. Install piping to permit valve servicing.

O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

P. Install piping free of sags and bends.

Q. Install fittings for changes in direction and branch connections.

R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

S. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

T. Install thermostats in hot-water circulation piping. Comply with requirements of the latest International Energy Code.

U. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

3.02 TESTING AND STERILIZATION

A. All water piping systems shall be properly tested to assure their being absolutely tight. In the case of pipes which are to be insulated, these tests shall be completed and the piping system proven to be absolutely tight before any insulation is applied. Wherever pipes are placed so that they will ultimately be concealed, these tests shall be conducted and the absolute tightness of each piping system shall be demonstrated before the system is concealed.

B. The procedure of these tests shall consist of subjecting a piping system to a hydrostatic pressure per Section 23 00 00. During the test period, all pipe, fittings and accessories in the particular piping system which is being tested shall be carefully inspected. If leaks are detected, such leaks shall be stopped by means designated by the Owner's duly authorized representative and the hydrostatic test shall again be applied. This procedure shall be repeated until, for an entire twenty-four hour period, no leaks can be found while the system being tested is subjected to the pressure mentioned above.

C. Wherever conditions permit, each piping system shall thereafter be subjected to its normal operating pressure and temperature for a period of no less than five (5) days. During that period, it shall be kept under the most careful observation. The piping systems must demonstrate the propriety of their installation by remaining absolutely tight during this period. Even though the completion of these tests is satisfactory, there is a continuing responsibility for the ultimate, proper, and satisfactory operation of such piping systems and their accessories.

D. After completion of the testing, the entire cold and hot water piping systems, with attached equipment, shall be thoroughly sterilized with a solution containing not less than 50 parts per million of available chlorine. The chlorinating materials shall be either liquid chlorine conforming to U. S. Army Specification No. 4-1 or calcium hypochlorite or chlorinated lime conforming to the requirements of Federal Specification O-C-114. The sterilizing solution shall

be allowed to remain in the system for a period of eight (8) hours during which time all valves and faucets shall be opened and closed several times. After sterilization, the solution shall be flushed from the system with clean water until the residual chlorine content is not greater than 0.2 parts per million.

E. The sterilization process shall be conducted as required by the Health Department of the “City of Houston”, and the specifications above, and upon completion of the process, the Health Department shall test and certify the cleanliness of the water piping system. The Plumbing Subcontractor shall pay all costs and charges incidental to this test and certification.

3.03 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."

F. Copper-Tubing, Push-on Joints: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.

G. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.

H. Ductile-Iron-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join ductile-iron pipe and grooved-end fittings according to AWWA C606 for ductile-iron-pipe, cut-grooved joints.

I. Steel-Piping Grooved Joints: Cut or roll groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

J. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.04 VALVE INSTALLATION

A. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 and smaller. Use butterfly for piping NPS 2-1/2 and larger.

B. Butterfly valves are not acceptable for any plumbing applications.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

E. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.05 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each domestic water pump.

B. Install bronze-hose flexible connectors in copper domestic water tubing.

C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.06 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (9.52 mm).

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches (1524 mm) with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches (1828.8 mm) with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches (2438.4 mm) with 3/8-inch rod.
4. NPS 2-1/2: 108 inches (2743.2 mm) with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet (304.8 cm) with 1/2-inch rod.
6. NPS 6: 10 feet (304.8 cm) with 5/8-inch rod.

F. Install supports for vertical copper tubing every 10 feet (304.8 cm).

3.07 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements for plumbing fixture for connection sizes.
   3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.08 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.09 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:
   1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Re-inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
   4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:
   1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   4. Cap and subject piping to static water pressure of 50 psig (344.74 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
   6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.
   4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
      a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
      b. Adjust calibrated balancing valves to flows indicated.
   5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
   6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
   7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
   8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow it to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow it to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use gate, ball valves with flanged ends for piping NPS 2-1/2 and larger.

2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use globe or ball valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION

SECTION 221119
DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASME A112.18.1 - Plumbing Supply Fittings; 2024.

B. ASME B1.20.7 - Hose Coupling Screw Threads (Inch); 1991 (Reaffirmed 2024).

C. ASSE 1001 - Performance Requirements for Atmospheric Type Vacuum Breakers; 2021.

D. ASSE 1010 - Performance Requirements for Water Hammer Arresters; 2025.

E. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers; 2023.

F. ASSE 1013 - Reduced Pressure Principle (RP) Backflow Prevention Assemblies; 2026.

G. ASSE 1017 - Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems; 2023.

H. ASSE 1018 - Performance Requirements for Trap Seal Primer Valves - Potable Water Supplied; 2023.

I. ASSE 1047 - Performance Requirements for Reduced Pressure Detector Backflow Prevention Assemblies; 2021 (Reaffirmed 2026).

J. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017 (Reapproved 2025).

K. AWWA C550 - Protective Interior Coatings for Valves and Hydrants; 2024.

L. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.

M. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

N. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

O. PDI-WH 201 - Water Hammer Arresters; 2017.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Coordinate with Commissioning Requirements indicated in Section 019100. This contractor is responsible to comply with all requirements for the above section.

1.03 SUMMARY

A. This Section includes the following domestic water piping specialties:
   1. Vacuum breakers.
   2. Backflow preventers.
   3. Water pressure-reducing valves.
   4. Balancing valves.
   5. Temperature-actuated water mixing valves.
   6. Strainers.
   7. Hose bibbs.
   8. Wall hydrants.
   9. Drain valves.
   10. Water hammer arresters.
   11. Air vents.
   12. Trap-seal primer valves.
   13. Trap-seal primer systems.

B. Related Sections:
   1. Section 013300 Submittals.
   2. Section 01524 Construction Waste Management
   3. Section 01352 LEED Requirements
   4. Section 01611 Environmental Management
   5. Section 01570 Pollution Prevention and Control

1.04 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (861.84 kPa), unless otherwise indicated.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

E. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
   1. Recycled Content:
      a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
   2. Local/Regional Materials:
      a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
      b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
   3. VOC data:
      a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal’s Standard GS-11.
      b. Submit manufacturer’s certification that products comply with Green Seal’s Standard GS-11
      c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
   4. Submit the following according to Conditions of the Construction Contract.
      a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
   5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
   6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.07 MAINTENANCE

A. Provide twelve (12) months maintenance of all materials and equipment under this section. Cost of the twelve (12) month normal and preventive maintenance shall be included within this scope of work.

PART 2 PRODUCTS

2.01 ENVIRONMENTALLY PREFERABLE PRODUCTS

A. Provide environmentally preferable products to the greatest extent possible.
   1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.

B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.

C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.02 RECYCLED CONTENT

A. Provide recycled content products to the greatest extent possible.
   1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.03 REGIONAL MATERIALS

A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
   1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles (804.67 kilometers) from the project site.
      a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
   2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles (804.67 kilometers) of the project site.

2.04 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Co.
      b. FEBCO; SPX Valves & Controls.
      c. J. R. Smith Corporation.
      d. Watts Industries, Inc.; Water Products Div.
      e. Zurn Plumbing Products Group; Wilkins Div.
   2. Standard: ASSE 1001.
   3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   4. Body: Bronze.
   5. Inlet and Outlet Connections: Threaded.
   6. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Legend Valve.
      b. MIFAB, Inc.
      c. Prier Products, Inc.

d. Watts Industries, Inc.; Water Products Div.
e. Woodford Manufacturing Company.
f. Zurn Plumbing Products Group; Light Commercial Operation.

2. Standard: ASSE 1011.
3. Body: Bronze, non-removable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

2.05 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. FEBCO; SPX Valves & Controls.
b. Watts Industries, Inc.; Water Products Div.
c. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psi (34.47 kPa) maximum, through middle 1/3 of flow range.
5. Size: As indicated on drawings.
6. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Reduced-Pressure-Detector, Fire-Protection Backflow-Preventer Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Ames Co.
b. FEBCO; SPX Valves & Controls.
c. Watts Industries, Inc.; Water Products Div.
d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1047 and FMG approved or UL listed.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 7 psig (48.26 kPa) maximum, through middle 1/3 of flow range.
5. Size: As indicated on plans.
6. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved.
7. End Connections: Flanged.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

2.06 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armstrong International, Inc.
b. Flo Fab Inc.
c. ITT Industries; Bell & Gossett Div.
d. NIBCO INC.
e. Taco, Inc.
f. Watts Industries, Inc.; Water Products Div.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: bronze,
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.07 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armstrong International, Inc.
b. Honeywell Water Controls.
c. Powers; a Watts Industries Co.
d. Symmons Industries, Inc.
e. Watts Industries, Inc.; Water Products Div.
f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig (861.84 kPa).
4. Type: Thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

2.08 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
1. Pressure Rating: 125 psig (861.84 kPa) minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
a. Strainers NPS 2 and Smaller: 0.020 inch (0.51 mm).
b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch (1.14 mm).
c. Strainers NPS 5 and Larger: 0.10 inch (2.54 mm).
6. Drain: Factory-installed, hose-end drain valve.

B. Icemaker Outlet Boxes:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Acorn Engineering Company.
b. IPS Corporation.
c. LSP Products Group, Inc.
d. Plastic Oddities; a division of Diverse Corporate Technologies.
2. Mounting: Recessed.
3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.

5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.09 HOSE BIBBS

A. Hose Bibbs:
1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig (861.84 kPa).
7. Vacuum Breaker: Integral non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Include operating key with each operating-key hose bibb.
14. Include wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Non-freeze Wall Hydrants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Light Commercial Operation.
2. Standard: ASME A112.21.3M for concealed outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig (861.84 kPa).
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Polished nickel bronze.
12. Operating Keys(s): One with each wall hydrant.

2.11 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.

6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.12 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AMTROL, Inc.
b. Josam Company.
c. MIFAB, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.13 AIR VENTS

A. Bolted-Construction Automatic Air Vents:
1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.14 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. MIFAB, Inc.
b. PPP Inc.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig (861.84 kPa) minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
   3. Do not install bypass piping around backflow preventers.
   4. Backflow preventer shall be certified by Contractor.
   5. Provide a floor drain within six (6) feet of each backflow preventer.

B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

C. Install water control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install thermometers and water regulators if specified.
   2. Install cabinet-type units recessed in or surface mounted on wall as specified.

F. Install Y-pattern strainers for water on supply side of each control valve, solenoid valve, and pump.

G. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
   1. Install shutoff valve on outlet if specified.
   2. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

H. Install freeze-resistant yard hydrants with riser pipe set in concrete or pavement. Do not encase canister in concrete.

I. Install water hammer arresters in water piping according to PDI-WH 201.

J. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

K. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

L. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

M. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.03 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Pressure vacuum breakers.
   2. Reduced-pressure-principle backflow preventers.
   3. Reduced-pressure-detector, fire-protection backflow-preventer assemblies.
   4. Primary, thermostatic, water mixing valves.
   5. Primary water tempering valves.
   6. Hose stations.
   7. Supply-type, trap-seal primer valves.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.04 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
   1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.05 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION

SECTION 221313
FACILITY SANITARY SEWERS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASME A112.14.1 - Backwater Valves; 2003 (Reaffirmed 2022).

B. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.

C. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2026.

D. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2026.

E. ASTM A674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe; 2022.

F. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe; 2018 (Reapproved 2022).

G. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2024.

H. ASTM B29 - Standard Specification for Refined Lead; 2019 (Reapproved 2025).

I. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe; 2020 (Reapproved 2025).

J. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2024a.

K. ASTM C150/C150M - Standard Specification for Portland Cement; 2024.

L. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2021.

M. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2026.

N. ASTM C1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2026.

O. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2026.

P. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2026.

Q. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping; 2025.

R. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020 (Reapproved 2024).

S. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2024, with Editorial Revision (2025).

T. ASTM D3839 - Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe; 2025.

U. ASTM D4161 - Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals; 2024.

V. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2014 (Reapproved 2021).

W. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.

X. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2021.

Y. AWWA C153/A21.53 - Ductile-Iron Compact Fittings; 2025.

Z. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances; 2023.

AA. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 60 In. (100 mm through 1500 mm); 2022.

BB. AWWA M23 - PVC Pipe—Design and Installation; 2020.

CC. AWWA M41 - Ductile-Iron Pipe and Fittings; 2025.

DD. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.

EE. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2020.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. Section Includes:
   1. Hub-and-spigot, cast-iron soil pipe and fittings.
   2. Hub-less cast-iron soil pipe and fittings.
   3. PVC pipe and fittings.
   4. Non-pressure-type transition couplings.
   5. Pressure-type pipe couplings.
   6. Expansion joints and deflection fittings.
   7. Backwater valves.
   8. Cleanouts.
   9. Encasement for piping.

1.04 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Pipe and fittings.
   2. Non-pressure and pressure couplings
   3. Expansion joints and deflection fittings.
   4. Backwater valves.
   5. Cleanouts.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:
   1. Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
   2. Show system piping in profile. Draw profiles to horizontal scale of not less than 1 inch (25.4 mm) equals 50 feet (1524 cm) and to vertical scale of not less than 1 inch equals 5 feet (152.4 cm). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

B. Product Certificates: For each type of pipe and fitting.

C. Field quality-control reports.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.07 FIELD CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Construction Manager no fewer than two days in advance of proposed interruption of service.

PART 2 PRODUCTS

2.01 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A74, Service class.

B. Gaskets: ASTM C564, rubber.

C. Calking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.02 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A888 or CISPI 301.

B. CISPI-Trademark, Shielded Couplings:
   1. Description: ASTM C1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Charlotte Pipe and Foundry Company.
      c. Dallas Specialty & Mfg. Co.
      d. Fernco Inc.
      e. Mission Rubber Company, LLC; a division of MCP Industries.
      f. Tyler Pipe; a subsidiary of McWane Inc.

C. Heavy-Duty, Shielded Couplings:
   1. Description: ASTM C1277 and ASTM C1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Clamp-All Corp.
      c. Dallas Specialty & Mfg. Co.
      d. Mission Rubber Company, LLC; a division of MCP Industries.
      e. Tyler Pipe; a subsidiary of McWane Inc.

D. Cast-Iron, Shielded Couplings:
   1. Description: ASTM C1277 with ASTM A48/A48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Charlotte Pipe and Foundry Company.
      c. Clamp-All Corp.
      d. Dallas Specialty & Mfg. Co.
      e. MG Piping Products Company.

f. Mission Rubber Company, LLC; a division of MCP Industries.
g. Tyler Pipe; a subsidiary of McWane Inc.

E. Unshielded Couplings:
1. Description: ASTM C1277 and ASTM C1461, rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C1440, thermoplastic elastomer (TPE) material; with corrosion-resistant-metal tension band and tightening mechanism on each end.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ANACO-Husky.
b. Charlotte Pipe and Foundry Company.
c. Clamp-All Corp.
d. Dallas Specialty & Mfg. Co.
e. MG Piping Products Company.
f. Mission Rubber Company, LLC; a division of MCP Industries.
g. Tyler Pipe; a subsidiary of McWane Inc.

F. PVC Gravity Sewer Piping:
1. Pipe and Fittings: ASTM F679, T-2 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F477, elastomeric seals for gasketed joints.

G. PVC Pressure Piping:
1. Pipe: AWWA C900, Class 150 PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, Class 150 PVC pipe with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

2.03 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground non-pressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
1. For Cast-Iron Soil Pipes: ASTM C564, rubber.
2. For Concrete Pipes: ASTM C443, rubber.
3. For Fiberglass Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
4. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
5. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:
1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Dallas Specialty & Mfg. Co.
b. Fernco Inc.
c. Logan Clay Pipe.
d. Mission Rubber Company, LLC; a division of MCP Industries.
e. NDS Inc.
f. Plastic Oddities.

D. Shielded, Flexible Couplings:
1. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Cascade Waterworks Mfg. Co.
    b. Dallas Specialty & Mfg. Co.
    c. Mission Rubber Company, LLC; a division of MCP Industries.

E. Ring-Type, Flexible Couplings:
1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Fernco Inc.
    b. Logan Clay Pipe.
    c. Mission Rubber Company, LLC; a division of MCP Industries.

F. Non-pressure-Type, Rigid Couplings:
1. Description: ASTM C1461, sleeve-type, reducing- or transition-type mechanical coupling; molded from ASTM C1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.
2. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. ANACO-Husky.

2.04 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:
1. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. EBAA Iron, Inc.
    b. Romac Industries, Inc.
    c. Star Pipe Products.

B. Ductile-Iron Expansion Joints:
1. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include rating for 250-psig (1725-kPa) minimum working pressure and for expansion indicated.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Dresser, Inc.
    b. EBAA Iron, Inc.
    c. Jay R. Smith Mfg Co; a division of Morris Group International.
    d. JCM Industries, Inc.

2.05 BACKWATER VALVES

A. Cast-Iron Backwater Valves:
1. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Jay R. Smith Mfg Co; a division of Morris Group International.
    b. Josam Company.
    c. Tyler Pipe; a subsidiary of McWane Inc.

d. WATTS.
e. Zurn Industries, LLC.

3. Horizontal type; with swing check valve and hub-and-spigot ends.
4. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
5. Terminal type; with bronze seat, swing check valve, and hub inlet.

B. PVC Backwater Valves:
1. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Canplas LLC.
b. IPS Corporation.
c. NDS Inc.
d. Plastic Oddities.
e. Sioux Chief Manufacturing Company, Inc.
f. Zurn Industries, LLC.

2.06 CLEANOUTS

A. Cast-Iron Cleanouts:
1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. MIFAB, Inc.
d. Tyler Pipe; a subsidiary of McWane Inc.
e. WATTS.
f. Zurn Industries, LLC.
3. Top-Loading Classification(s): Medium Duty and Extra-Heavy Duty.
4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:
1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Canplas LLC.
b. IPS Corporation.
c. NDS Inc.
d. Plastic Oddities.
e. Sioux Chief Manufacturing Company, Inc.
f. Zurn Industries, LLC.

2.07 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350 (ACI 350M), and the following:
1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.

4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi (27579.04 kPa) minimum, with 0.45 maximum water/cementitious materials ratio.
   1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
   2. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27579.04 kPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
   1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
      a. Invert Slope: 2 percent through manhole.
   2. Benches: Concrete, sloped to drain into channel.
      a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20684.28 kPa) minimum, with 0.58 maximum water/cementitious materials ratio.
   1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
   2. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed steel.

PART 3 EXECUTION

3.01 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.02 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of micro tunneling.

F. Install gravity-flow, non pressure, drainage piping according to the following:
   1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
   2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
   3. Install piping with 48-inch minimum cover.
   4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   6. Install ductile-iron, gravity sewer piping according to ASTM A746.
   7. Install ABS sewer piping according to ASTM D2321 and ASTM F1668.

8. Install PVC cellular-core sewer piping according to ASTM D2321 and ASTM F1668.
9. Install PVC corrugated sewer piping according to ASTM D2321 and ASTM F1668.
10. Install PVC profile sewer piping according to ASTM D2321 and ASTM F1668.
11. Install PVC Type PSM sewer piping according to ASTM D2321 and ASTM F1668.
12. Install PVC gravity sewer piping according to ASTM D2321 and ASTM F1668.
13. Install fiberglass sewer piping according to ASTM D3839 and ASTM F1668.
14. Install nonreinforced-concrete sewer piping according to ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."
15. Install reinforced-concrete sewer piping according to ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."

G. Install force-main, pressure piping according to the following:
1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
2. Install piping with 36-inch minimum cover.
3. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.
4. Install ductile-iron special fittings according to AWWA C600.
5. Install PVC pressure piping according to AWWA M23 or to ASTM D2774 and ASTM F1668.
6. Install PVC water-service piping according to ASTM D2774 and ASTM F1668.

H. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A674 or AWWA C105/A21.5:
1. Hub-and-spigot, cast-iron soil pipe.
2. Hubless cast-iron soil pipe and fittings.
3. Expansion joints and deflection fittings.

I. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.03 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, non-pressure, drainage piping according to the following:
1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
5. Join ABS sewer piping according to ASTM D2321 for elastomeric-seal joints.
6. Join PVC cellular-core sewer piping according to ASTM D2321 and ASTM F891 for solvent-cemented joints.
7. Join PVC corrugated sewer piping according to ASTM D2321.
8. Join PVC profile sewer piping according to ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.
9. Join PVC Type PSM sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
10. Join PVC gravity sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
11. Join fiberglass sewer piping according to ASTM D4161 for elastomeric-seal joints.
12. Join nonreinforced-concrete sewer piping according to ASTM C14 (ASTM C14M) and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.

13. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
14. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.

B. Join force-main, pressure piping according to the following:
1. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
2. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
3. Join PVC pressure piping according to AWWA M23 for gasketed joints.
4. Join PVC water-service piping according to ASTM D2855.
5. Join dissimilar pipe materials with pressure-type couplings.

C. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use non-pressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
a. Shielded flexible couplings for pipes of same or slightly different OD.
b. Unshielded, increaser/reducer-pattern, flexible or rigid couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
2. Use pressure pipe couplings for force-main joints.

3.04 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.05 BACKWATER VALVE INSTALLATION

A. Install horizontal-type backwater valves in piping manholes or pits.

B. Install combination horizontal and manual gate-type valves in piping and in manholes.

C. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

3.06 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
1. Use Light-Duty, top-loading classification cleanouts in unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches (304.8 mm) deep. Set with tops 1 inch (25.4 mm) above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.07 CONNECTIONS

A. Connect non-pressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."

B. Connect force-main piping to building's sanitary force mains specified in Section 221316 "Sanitary Waste and Vent Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch (150-mm) overlap with not less than 6 inches (152.4 mm) of concrete with 28-day compressive strength of 3000 psi (20684.28 kPa).
2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (152.4 mm) of concrete with 28-day compressive strength of 3000 psi (20684.28 kPa).
3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches (76.2 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of, and be flush with, inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches (152.4 mm) of concrete for minimum length of 12 inches (304.8 mm) to provide additional support of collar from connection to undisturbed ground.
    a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20684.28 kPa) unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

D. Connect to grease interceptors specified in Section 221323 "Sanitary Waste Interceptors."

3.08 IDENTIFICATION

A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
    1. Use warning tape or] detectable warning tape over ferrous piping.
    2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.09 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (609.6 mm) of backfill is in place, and again at completion of Project.
    1. Submit separate report for each system inspection.
    2. Defects requiring correction include the following:
        a. Alignment: Less than full diameter of inside of pipe is visible between structures.
        b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
        c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
        d. Infiltration: Water leakage into piping.
        e. Exfiltration: Water leakage from or around piping.
    3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
    4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
    1. Do not enclose, cover, or put into service before inspection and approval.
    2. Test completed piping systems according to requirements of authorities having jurisdiction.

3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
    a. Fill sewer piping with water. Test with pressure of at least 10-foot (3-m) head of water, and maintain such pressure without leakage for at least 15 minutes.
    b. Close openings in system and fill with water.
    c. Purge air and refill with water.
    d. Disconnect water supply.
    e. Test and inspect joints for leaks.
6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    a. Test plastic gravity sewer piping according to ASTM F1417.
    b. Test concrete gravity sewer piping according to ASTM C1628.
7. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig (1034.21 kPa).
    a. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
    b. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
8. Manholes: Perform hydraulic test according to ASTM C969 (ASTM C969M).

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION

SECTION 221316
SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASME A112.3.1 - Stainless Steel Drainage Systems for Sanitary DWV, Storm, and Vacuum Applications Above and Below Ground; 2007 (Reaffirmed 2022).

B. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).

C. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2021.

D. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV; 2021.

E. ASME B16.24 - Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500; 2021.

F. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV; 2022.

G. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).

H. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.

I. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2026.

J. ASTM A674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe; 2022.

K. ASTM B29 - Standard Specification for Refined Lead; 2019 (Reapproved 2025).

L. ASTM B32 - Standard Specification for Solder Metal; 2020.

M. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.

N. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2026.

O. ASTM B813 - Standard Specification for Water Flushable Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2024.

P. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.

Q. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2026.

R. ASTM C1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2026.

S. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2026.

T. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings; 2022.

U. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2026.

V. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020 (Reapproved 2024).

W. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings; 2024.

X. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2025.

Y. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020 (Reapproved 2024).

Z. ASTM D3311 - Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns; 2022 .

AA. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings; 2026.

BB. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2014 (Reapproved 2021).

CC. ASTM F628 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core; 2024.

DD. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2025.

EE. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2024).

FF. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.

GG. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2021.

HH. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2023.

II. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2023.

JJ. AWWA C153/A21.53 - Ductile-Iron Compact Fittings; 2025.

KK. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances; 2023.

LL. AWWA C606 - Grooved and Shouldered Joints; 2022.

MM. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.

NN. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2020.

OO. NSF 14 - Plastics Piping System Components and Related Materials; 2025.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. Section Includes:
   1. Hub-and-spigot, cast-iron soil pipe and fittings.
   2. Hubless, cast-iron soil pipe and fittings.
   3. Galvanized-steel pipe and fittings.
   4. Stainless-steel drainage pipe and fittings.
   5. Ductile-iron pipe and fittings.
   6. Copper tube and fittings.
   7. ABS pipe and fittings.
   8. PVC pipe and fittings.
   9. Specialty pipe fittings.
   10. Encasement for underground metal piping.

B. Related Requirements:
   1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
   2. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.

3. Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Shop Drawings: For hub-less, single-stack drainage system. Include plans, elevations, sections, and details.

1.05 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.06 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: 10-foot head of water.
   2. Waste, Force-Main Piping: 100 psig (689.48 kPa) .

2.02 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.03 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AB & I Foundry; a part of the McWane family of companies.
   2. Charlotte Pipe and Foundry Company.
   3. NewAge Casting.
   4. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings: ASTM A74, Extra Heavy class(es).

C. Gaskets: ASTM C564, rubber.

D. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.04 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AB & I Foundry; a part of the McWane family of companies.
   2. Charlotte Pipe and Foundry Company.
   3. NewAge Casting.
   4. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings: ASTM A 888 or CISPI 301.

C. Single-Stack Aerator Fittings: ASME B16.45, hubless, cast-iron aerator and deaerator drainage fittings.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conine Manufacturing Co., Inc.
      b. SE Sovent.

D. CISPI, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Charlotte Pipe and Foundry Company.
      c. Dallas Specialty & Mfg. Co.
      d. Fernco Inc.
      e. Ideal Clamp Products, Inc.
      f. Josam Company.
      g. Matco-Norca.
      h. MIFAB, Inc.
      i. Mission Rubber Company, LLC; a division of MCP Industries.
      j. NewAge Casting.
      k. Tyler Pipe; a subsidiary of McWane Inc.
   2. Standards: ASTM C1277 and CISPI 310.
   3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

E. Heavy-Duty, Hub-less-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      b. Charlotte Pipe and Foundry Company.
      c. Clamp-All Corp.
      d. Dallas Specialty & Mfg. Co.
      e. Ideal Clamp Products, Inc.
      f. MIFAB, Inc.
      g. Mission Rubber Company, LLC; a division of MCP Industries.
      h. NewAge Casting.
      i. Tyler Pipe; a subsidiary of McWane Inc.
   2. Standards: ASTM C1277 and ASTM C1540.
   3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

F. Cast-Iron, Hub-less-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Charlotte Pipe and Foundry Company.
      b. MG Piping Products Company.
   2. Standard: ASTM C1277.
   3. Description: Two-piece ASTM A48/A48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.05 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:
   1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
   2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
   3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

C. Ductile-Iron, Grooved-Joint Piping: AWWA C151/A21.51, with round-cut-grooved ends according to AWWA C606.

D. Ductile-Iron, Grooved-End Pipe Appurtenances:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International.
   b. Shurjoint-Apollo Piping Products USA Inc.
   c. Smith-Cooper International.
   d. Star Pipe Products.
   e. Victaulic Company.
2. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.06 COPPER TUBE AND FITTINGS

A. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B88, Type L and Type M, water tube, drawn temper.

D. Soft Copper Tube: ASTM B88, Type L, water tube, annealed temper.

E. Copper Pressure Fittings:
1. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.07 ABS PIPE AND FITTINGS

A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

B. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.

C. Cellular-Core ABS Pipe: ASTM F628, Schedule 40.

D. ABS Socket Fittings: ASTM D2661, made to ASTM D3311, drain, waste, and vent patterns.

E. Solvent Cement: ASTM D2235.

2.08 PVC PIPE AND FITTINGS

A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

B. Solid-Wall PVC Pipe: ASTM D2665, drain, waste, and vent.

C. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

D. PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

E. Adhesive Primer: ASTM F656.

F. Solvent Cement: ASTM D2564.

2.09 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   2. Unshielded, No pressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Dallas Specialty & Mfg. Co.
         2) Fernco Inc.
         3) Froet Industries LLC.
         4) Mission Rubber Company, LLC; a division of MCP Industries.
         5) Plastic Oddities.
      b. Standard: ASTM C 1173.
      c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
      d. End Connections: Same size as and compatible with pipes to be joined.
      e. Sleeve Materials:
         1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
         2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D 5926, PVC.
         3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
   3. Shielded, Non-pressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cascade Waterworks Mfg. Co.
         2) Mission Rubber Company, LLC; a division of MCP Industries.
      b. Standard: ASTM C 1460.
      c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
      d. End Connections: Same size as and compatible with pipes to be joined.

B. Dielectric Fittings:
   1. Dielectric Unions:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) A.Y. McDonald Mfg. Co.
         2) Capitol Manufacturing Company.
         3) Central Plastics Company.
         4) HART Industrial Unions, LLC.
         5) Jomar Valve.
         6) Matco-Norca.
         7) WATTS.
         8) Wilkins.
         9) Zurn Industries, LLC.
      b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: 125 psig (861.84 kPa) minimum at 180 deg F.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

2. Dielectric Flanges:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Capitol Manufacturing Company.
      2) Central Plastics Company.
      3) Matco-Norca.
      4) WATTS.
      5) Wilkins.
      6) Zurn Industries, LLC.
   b. Description:
      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.
      3) Pressure Rating: 125 psig (861.84 kPa) minimum at 180 deg F.
      4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
3. Dielectric-Flange Insulating Kits:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Advance Products & Systems, Inc.
      2) Calpico, Inc.
      3) Central Plastics Company.
      4) Pipeline Seal and Insulator, Inc.
   b. Description:
      1) Nonconducting materials for field assembly of companion flanges.
      2) Pressure Rating: 150 psig (1034.21 kPa) .
      3) Gasket: Neoprene or phenolic.
      4) Bolt Sleeves: Phenolic or polyethylene.
      5) Washers: Phenolic with steel backing washers.
4. Dielectric Nipples:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Elster Perfection Corporation.
      2) Grinnell G-Fire by Johnson Controls Company.
      3) Josam Company.
      4) Matco-Norca.
      5) Precision Plumbing Products.
      6) Victaulic Company.
   b. Description:
      1) Standard: IAPMO PS 66.
      2) Electroplated steel nipple.
      3) Pressure Rating: 300 psig (2068.43 kPa) at 225 deg F .
      4) End Connections: Male threaded or grooved.
      5) Lining: Inert and noncorrosive, propylene.

PART 3 EXECUTION

3.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
   1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
   2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
   1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
   2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
      a. Straight tees, elbows, and crosses may be used on vent lines.
   3. Do not change direction of flow more than 90 degrees.
   4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
      a. Reducing size of waste piping in direction of flow is prohibited.

K. Lay buried building waste piping beginning at low point of each system.
   1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
   2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
   3. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
   1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A674 or AWWA C105/A21.5.

N. Install steel piping according to applicable plumbing code.

O. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

Q. Install aboveground ABS piping according to ASTM D2661.

R. Install aboveground PVC piping according to ASTM D2665.

S. Install underground PVC piping according to ASTM D2321.

T. Install engineered soil and waste and vent piping systems as follows:
   1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
   2. Hub-less, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
   3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

U. Install underground, ductile-iron, force-main piping according to AWWA C600.
   1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
   2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
   3. Install encasement on piping according to ASTM A674 or AWWA C105/A21.5.

V. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
   1. Install encasement on piping according to ASTM A674 or AWWA C105/A21.5.

W. Install force mains at elevations indicated.

X. Plumbing Specialties:
   1. Install backwater valves in sanitary waster gravity-flow piping.
      a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
   2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
      a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
      b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
   3. Install drains in sanitary waste gravity-flow piping.
      a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

Y. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Z. Install sleeves for piping penetrations of walls, ceilings, and floors.
   1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

AA. Install sleeve seals for piping penetrations of concrete walls and slabs.
   1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

BB. Install escutcheons for piping penetrations of walls, ceilings, and floors.
   1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hub-less, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hub-less-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
   1. Cut threads full and clean using sharp dies.
   2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
      a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
      b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
      c. Do not use pipe sections that have cracked or open welds.

E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.

F. Join copper tube and fittings with soldered joints according to ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 appendixes.
   3. PVC Piping: Join according to ASTM D2855 and ASTM D2665 appendixes.

J. Dielectric Fittings:
   1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
   2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
   3. Dielectric Fittings for NPS 2-1/2 to NPS 4 : Use dielectric flanges.

3.04 VALVE INSTALLATION

A. Comply with requirements in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping" for general-duty valve installation requirements.

B. Shutoff Valves:
   1. Install shutoff valve on each sewage pump discharge.
   2. Install gate or full-port ball valve for piping NPS 2 and smaller.
   3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.
   1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
   2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
   3. Install backwater valves in accessible locations.
   4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.05 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment.
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   3. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
   4. Vertical Piping: MSS Type 8 or Type 42, clamps.
   5. Install individual, straight, horizontal piping runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   6. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   7. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Install hangers for PVCpiping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping and tubing within 12 inches (304.8 mm) of each fitting, valve, and coupling.

3.06 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:
   1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
   5. Equipment: Connect waste piping as indicated.
      a. Provide shutoff valve if indicated and union for each connection.
      b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:
   1. Sanitary Sewer: To exterior force main.
   2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.07 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.08 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
      a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
      a. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
      a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
      b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
      c. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
      a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
      b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
      c. Air pressure must remain constant without introducing additional air throughout period of inspection.
      d. Inspect plumbing fixture connections for gas and water leaks.
   5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
      a. Expose work that was covered or concealed before it was tested.
   2. Cap and subject piping to static-water pressure of 50 psig (344.74 kPa) above operating pressure, without exceeding pressure rating of piping system materials.
      a. Isolate test source and allow to stand for four hours.
      b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.09 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed ABS Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall bethe following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 and larger shall be the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings hubless-piping couplings; and coupled joints.

D. Aboveground, vent piping NPS 4 and smaller shall be the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Copper Type DWV tube, copper drainage fittings, and soldered joints.
   a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
4. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
5. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
6. Galvanized-steel pipe, drainage fittings, and threaded joints.

E. Underground, soil, waste, and vent piping NPS 6 and smaller shall be the following:
1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

END OF SECTION

SECTION 221319
SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:
   1. Cleanouts.
   2. Floor drains.
   3. Trench drains.
   4. Roof flashing assemblies.
   5. Through-penetration fire-stop assemblies.
   6. Miscellaneous sanitary drainage piping specialties.
   7. Flashing materials.

B. Related Sections:
   1. Section 013300 Submittals.
   2. Section 01524 Construction Waste Management
   3. Section 01352 LEED Requirements
   4. Section 01611 Environmental Management
   5. Section 01570 Pollution Prevention and Control

1.03 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

1.04 REFERENCE STANDARDS

A. ASME A112.6.3 - Floor Drains; 2022.

B. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.

C. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2026.

D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

E. ASTM B32 - Standard Specification for Solder Metal; 2020.

F. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2026.

G. ASTM D4068 - Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane; 2017 (Reapproved 2022).

H. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.

1.05 SUBMITTALS

A. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.

1. Show fabrication and installation details for frost-resistant vent terminals.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

D. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
   1. Recycled Content:
      a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
   2. Local/Regional Materials:
      a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
      b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
   3. VOC data:
      a. Submit manufacturer's product data for joint compounds. Indicate VOC and chemical component limits of the product. Submit MSDS highlighting VOC and chemical component limits. VOC contents and chemical component limits must be less than the limits of Green Seal’s Standard GS-11.
      b. Submit manufacturer’s certification that products comply with Green Seal’s Standard GS-11
      c. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
   4. Submit the following according to Conditions of the Construction Contract.
      a. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:
   5. General: Submit additional LEED submittal requirements included in other sections of the Specifications.
   6. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

1.06 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.07 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.01 ENVIRONMENTALLY PREFERABLE PRODUCTS

A. Provide environmentally preferable products to the greatest extent possible.
   1. To the greatest extent possible, provide products and materials that promote stewardship of the earth's resources, promote good indoor environmental quality (IEQ), and promote efficiencies in operational performance.

B. Provide products listed on the EPA Comprehensive Procurement Guidelines to the greatest extent practicable.

C. Provide products listed on the USGBC Directory of Products and Services to the greatest extent possible.

2.02 RECYCLED CONTENT

A. Provide recycled content products to the greatest extent possible.
   1. To the greatest extent possible, provide materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10% of the total value of the materials in the project.

2.03 REGIONAL MATERIALS

A. Provide Regional materials and products to the greatest extent possible that are extracted and manufactured within the region.
   1. Provide materials and products that use a minimum of 20 % of building products that are manufactured regionally within a radius of 500 miles (804.67 kilometers) from the project site.
      a. Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesman.
   2. Of the regionally manufactured materials used and documented, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles (804.67 kilometers) of the project site.

2.04 CLEANOUTS

A. Exposed Metal Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. MIFAB, Inc.
      c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
   3. Size: Same as connected drainage piping
   4. Body Material: Cast-iron soil pipe test tee as required to match connected piping.
   5. Closure: Countersunk plug.
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
   7. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      c. Tyler Pipe; Wade Div.
      d. Watts Drainage Products Inc.
      e. Zurn Plumbing Products Group; Light Commercial Operation.
   2. Standard: ASME A112.36.2M for adjustable housing cast-iron soil pipe with cast-iron ferrule heavy-duty, adjustable housing threaded, adjustable housing cleanout.
   3. Size: Same as connected branch.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub less, cast-iron soil pipe test tee as required to match connected piping.
5. Size: Same as connected branch.
6. Body: PVC.
7. Closure Plug: PVC.
8. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.05 FLOOR DRAINS

A. Cast-Iron Floor Drains:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. MIFAB, Inc.
      c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
      f. Zurn Plumbing Products Group; Light Commercial Operation.
   2. Standard: ASME A112.6.3.
   3. Pattern: Sanitary drain.
   4. Body Material: Gray iron.

B. Wall Box:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Durgo, Inc.
      b. Oatey.
      c. RectorSeal.
      d. Studor, Inc.
   2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
   3. Size: About 9 inches (228.6 mm) wide by 8 inches (203.2 mm) high by 4 inches (101.6 mm) deep.

2.06 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Engineering Company; Elmdor / Stoneman Div.
      b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of from pipe, with galvanized-steel boot reinforcement and counter flashing fitting.
   1. Open-Top Vent Cap: Without cap.
   2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
   3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.07 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Fires top Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ProSet Systems Inc.
   2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
   3. Size: Same as connected soil, waste, or vent stack.
   4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
   5. Stack Fitting: ASTM A48/A48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
   6. Special Coating: Corrosion resistant on interior of fittings.

2.08 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:
   1. Description: Shop or field fabricate from ASTM A74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564, rubber gaskets.
   2. Size: Same as connected waste piping.

B. Deep-Seal Traps:
   1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
   2. Size: Same as connected waste piping.
      a. NPS 2: 4-inch- minimum water seal.
      b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:
   1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
   2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings:
   1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
   2. Body: Bronze or cast iron.
   3. Inlet: Opening in top of body.
   4. Outlet: Larger than inlet.
   5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:
   1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches (50.8 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
   2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:
   1. Description: Counter flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
   2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:
1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counter flashing.

I. Expansion Joints:
1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.09 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
1. General Applications: 12 oz/sq. ft.
2. Vent Pipe Flashing: 8 oz/sq. ft.

B. Zinc-Coated Steel Sheet: ASTM A653/A653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 75 feet (2286 cm) for piping NPS 4 and smaller and 100 feet (3048 cm) for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
   a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
   b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
   c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

H. Install through-penetration firestop assemblies in plastic stacks at floor penetrations.

I. Assemble open drain fittings and install with top of hub 2 inches (50.8 mm) above floor.

J. Install deep-seal traps on floor drains and other waste outlets, as required.

K. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.

L. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

M. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

N. Install vent caps on each vent pipe passing through roof.

O. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

P. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

Q. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

3.02 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (254 mm), and skirt or flange extending at least 8 inches (203.2 mm) around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (203.2 mm) around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (203.2 mm) around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.03 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled Neutralization tanks and their installation, including piping and electrical connections, and to assist in testing.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.04 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 221320
SANITARY DRAINS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Floor drains.
   2. Floor sinks.
   3. Trench drains.
   4. Channel drainage systems.

1.03 DEFINITIONS

A. ABS: Acrylonitrile-butadiene styrene.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene.

D. PE: Polyethylene.

E. PP: Polypropylene.

F. PVC: Polyvinyl chloride.

1.04 REFERENCE STANDARDS

A. ASME A112.3.1 - Stainless Steel Drainage Systems for Sanitary DWV, Storm, and Vacuum Applications Above and Below Ground; 2007 (Reaffirmed 2022).

B. ASME A112.6.3 - Floor Drains; 2022.

C. ASME A112.6.7 - Sanitary Floor Sinks; 2022.

D. NSF 14 - Plastics Piping System Components and Related Materials; 2025.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

2.01 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.02 FLOOR DRAINS

A. Cast-Iron Floor Drains:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. pJay R. Smith Mfg Co; a division of Morris Group International.
      b. Josam Company.
      c. MIFAB, Inc.
      d. Prier Products, Inc.
      e. Sioux Chief Manufacturing Company, Inc.
      f. Wade; a subsidiary of McWane Inc.
      g. WATTS.
      h. Zurn Industries, LLC.
   2. Standard: ASME A112.6.3.

3. Pattern: Floor drain.
4. Body Material: Gray iron .
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Outlet: Bottom.
8. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel .
9. Sediment Bucket: Not required .
10. Top or Strainer Material: Nickel bronze.
11. Top of Body and Strainer Finish: Nickel bronze.
12. Top Shape: Square.

2.03 FLOOR SINKS

A. Cast-Iron Floor Sinks:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Commercial Enameling Company.
      b. Jay R. Smith Mfg Co; a division of Morris Group International.
      c. Josam Company.
      d. Wade; a subsidiary of McWane Inc.
      e. WATTS.
      f. Zurn Industries, LLC.
   2. Standard: ASME A112.6.7.
   3. Pattern: Floor drain.
   4. Body Material: Cast iron.
   5. Anchor Flange: Required, with seepage holes.
   6. Outlet: Bottom, no-hub connection.
   7. Coating on Interior Surfaces: Acid-resistant enamel .
   8. Sediment Bucket: Required.
   9. Internal Strainer: Not required.
   10. Internal Strainer Material: Aluminum.
   11. Top Grate Material: Cast iron, hinged.
   12. Top of Body and Grate Finish: Acid-resistant enamel .
   13. Top Shape: Square.
   14. Top Loading Classification: No traffic loading.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
   3. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
   4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
      a. Maintain integrity of waterproof membranes where penetrated.
   5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. Install trench drains at low points of surface areas to be drained.
   1. Set grates of drains flush with finished surface, unless otherwise indicated.

C. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.
   1. Install on support devices, so that top will be flush with adjacent surface.

D. Install open drain fittings with top of hub 1 inch (25.4 mm) above floor.

3.02 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.

D. Install piping adjacent to equipment to allow service and maintenance.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.03 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.04 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 221413
FACILITY STORM DRAINAGE PIPING

SECTION 22 14 13

FACILITY STORM DRAINAGE PIPING

PART 1 GENERAL

3.01 REFERENCE STANDARDS

A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2026.

B. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2021.

C. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).

D. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).

E. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.

F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

G. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2026.

H. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service; 2026.

I. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2026.

J. ASTM A536 - Standard Specification for Ductile Iron Castings; 2026a.

K. ASTM A674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe; 2022.

L. ASTM B29 - Standard Specification for Refined Lead; 2019 (Reapproved 2025).

M. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2026.

N. ASTM C1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2026.

O. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2026.

P. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings; 2022.

Q. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020 (Reapproved 2024).

R. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings; 2024.

S. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2025.

T. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020 (Reapproved 2024).

U. ASTM D3311 - Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns; 2022 .

V. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings; 2026.

W. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2014 (Reapproved 2021).

X. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2025.

Y. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2024).

Z. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.

AA. AWWA C606 - Grooved and Shouldered Joints; 2022.

BB. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.

CC. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2020.

DD. NSF 14 - Plastics Piping System Components and Related Materials; 2025.

3.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

3.03 SUMMARY

A. Section Includes:
   1. Hub-and-spigot, cast-iron soil pipe and fittings.
   2. Hubless, cast-iron soil pipe and fittings.
   3. PVC pipe and fittings.
   4. Specialty pipe and fittings.
   5. Encasement for underground metal piping.

3.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Shop Drawings: For siphonic roof drainage system. Include calculations, plans, and details.

3.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Structural members to which drainage piping will be attached or suspended from.

B. Field quality-control reports.

3.06 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 PRODUCTS

4.01 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water .

4.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AB & I Foundry; a part of the McWane family of companies.
2. Charlotte Pipe and Foundry Company.
3. NewAge Casting.
4. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings:
1. Marked with CISPI collective trademark and NSF certification mark.
2. Class: ASTM A74, Service class(es).

C. Gaskets: ASTM C564, rubber.

D. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

4.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AB & I Foundry; a part of the McWane family of companies.
2. Charlotte Pipe and Foundry Company.
3. NewAge Casting.
4. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings:
1. Marked with CISPI collective trademark and NSF certification mark.
2. Standard: ASTM A 888 or CISPI 301.

C. CISPI, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ANACO-Husky.
b. Charlotte Pipe and Foundry Company.
c. Dallas Specialty & Mfg. Co.
d. Fernco Inc.
e. Ideal Clamp Products, Inc.
f. Matco-Norca.
g. MIFAB, Inc.
h. Mission Rubber Company, LLC; a division of MCP Industries.
i. NewAge Casting.
j. Tyler Pipe; a subsidiary of McWane Inc.
2. Couplings shall bear CISPI collective trademark and NSF certification mark.
3. Standards: ASTM C1277 and CISPI 310. ???Insert standard???.
4. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ANACO-Husky.
b. Charlotte Pipe and Foundry Company.
c. Clamp-All Corp.
d. Dallas Specialty & Mfg. Co.
e. Ideal Clamp Products, Inc.
f. MIFAB, Inc.
g. Mission Rubber Company, LLC; a division of MCP Industries.
h. NewAge Casting.
i. Tyler Pipe; a subsidiary of McWane Inc.
2. Standard: ASTM C1540. ???Insert standard???.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

E. Cast-Iron, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Charlotte Pipe and Foundry Company.
b. MG Piping Products Company.
2. Standard: ASTM C1277. ???Insert standard???.
3. Description: Two-piece ASTM A48/A48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

F. Cast-Iron Flanges: ASME B16.1, Class 125.
1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International.
b. Grinnell G-Fire by Johnson Controls Company.
c. Shurjoint-Apollo Piping Products USA Inc.
d. Smith-Cooper International.
e. Victaulic Company.
2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A536 ductile-iron castings, ASTM A47/A47M malleable-iron castings, ASTM A234/A234M forged-steel fittings, or ASTM A106/A106M steel pipes with dimensions matching ASTM A53/A53M steel pipe, and complying with AWWA C606 for grooved ends.
3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

4.04 PVC PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Charlotte Pipe and Foundry Company.
2. GF Piping Systems.
3. JM Eagle; J-M Manufacturing Co., Inc.
4. Mueller Industries, Inc.
5. National Pipe and Plastic, Inc.
6. North America Pipe Corporation.
7. Rocky Mountain Colby Pipe Company.
8. Silver-line Plastics.

B. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

C. Solid-Wall PVC Pipe: ASTM D2665; drain, waste, and vent.

D. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

E. PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

F. Adhesive Primer: ASTM F656.

G. Solvent Cement: ASTM D2564.

4.05 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
   3. Unshielded, Nonpressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Dallas Specialty & Mfg. Co.
         2) Fernco Inc.
         3) Mission Rubber Company, LLC; a division of MCP Industries.
         4) Plastic Oddities.
      b. Standard: ASTM C 1173.
      c. Description: Elastomeric sleeve, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
      d. Sleeve Materials:
         1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
         2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D 5926, PVC.
         3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
   4. Shielded, Nonpressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cascade Waterworks Mfg. Co.
         2) Mission Rubber Company, LLC; a division of MCP Industries.
      b. Standard: ASTM C 1460.
      c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
      d. End Connections: Same size as and compatible with pipes to be joined.

B. Dielectric Fittings:
   1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
   2. Dielectric Unions:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) A.Y. McDonald Mfg. Co.
         2) Capitol Manufacturing Company.
         3) Central Plastics Company.
         4) HART Industrial Unions, LLC.
         5) Jomar Valve.
         6) Matco-Norca.
         7) WATTS.
         8) Zurn Industries, LLC.
      b. Description:
         1) Standard: ASSE 1079.
         2) Pressure Rating: 150 psig (1034.21 kPa) minimum at 180 deg F.
         3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Central Plastics Company.
      2) Matco-Norca.
      3) WATTS.
      4) Zurn Industries, LLC.
   b. Description:
      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.
      3) Pressure Rating: 150 psig (1034.21 kPa) minimum at 180 deg F.
      4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Insulating Kits:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Advance Products & Systems, Inc.
      2) Calpico, Inc.
      3) Central Plastics Company.
      4) GPT; an EnPro Industries company.
   b. Description:
      1) Nonconducting materials for field assembly of companion flanges.
      2) Pressure Rating: 150 psig (1034.21 kPa).
      3) Gasket: Neoprene or phenolic.
      4) Bolt Sleeves: Phenolic or polyethylene.
      5) Washers: Phenolic with steel-backing washers.

PART 3 EXECUTION

5.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

5.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
   1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
   2. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
   1. Do not change direction of flow more than 90 degrees.
   2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
      a. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building piping beginning at low point of each system.
   1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
   2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
   3. Maintain swab in piping and pull past each joint as completed.

M. Install piping at the following minimum slopes unless otherwise indicated:
   1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A674 or AWWA C105/A21.5.

O. Install steel piping according to applicable plumbing code.

P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

Q. Install aboveground ABS piping according to ASTM D2661.

R. Install aboveground PVC piping according to ASTM D2665.

S. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

T. Install sleeves for piping penetrations of walls, ceilings, and floors.
   1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slabs.
   1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors.
   1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

5.03 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints:
   1. Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Plastic, Non-pressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 appendices.
3. PVC Piping: Join according to ASTM D2855 and ASTM D2665 appendices.

5.04 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Vertical Piping: MSS Type 8 or Type 42, clamps.
   3. Install individual, straight, horizontal piping runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

C. Install hangers for cast-iron piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping and tubing within 12 inches (304.8 mm) of each fitting and coupling.

F. Support vertical cast-iron piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.

G. Support vertical PVC piping with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

5.05 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.
   1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.

5.06 IDENTIFICATION

A. Identify exposed storm drainage piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

5.07 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.
    a. Expose work that was covered or concealed before it was tested.
3. Test Procedure:
    a. Test storm drainage piping, except outside leaders, on completion of roughing-in.
    b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
    a. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig (344.74 kPa) above operating pressure, without exceeding pressure rating of piping system materials.
    a. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

D. Piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

5.08 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

5.09 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

D. Underground storm drainage piping NPS 6 and smaller any of the following:

1. Extra Heavy class, cast-iron soil pipe and fittings; and caulked joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

E. Underground, storm drainage piping NPS 8 and larger shall be the following:
1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.

END OF SECTION

SECTION 223300
ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ANSI Z21.22 - American National Standard for Relief Valves for Hot Water Supply Systems; 2015 (Reaffirmed 2025).

B. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).

C. ASSE 1003 - Water Pressure Reducing Valves for Potable Water Distribution Systems; 2023.

D. ASSE 1010 - Performance Requirements for Water Hammer Arresters; 2025.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NSF 5 - Water Heaters, Hot Water Supply Boilers, and Heat Recovery Equipment; 2024.

G. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum

H. NSF 372 - Drinking Water System Components - Lead Content; 2024.

I. PDI-WH 201 - Water Hammer Arresters; 2017.

J. UL 1453 - Standard for Electric Booster and Commercial Storage Tank Water Heaters; Current Edition, Including All Revisions.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. Section Includes:
   1. Commercial, electric, storage, domestic-water heaters.
   2. Commercial, light-duty, storage, electric, domestic-water heaters.
   3. Domestic-water heater accessories.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

C. Shop Drawings:
   1. Include diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.

B. Seismic Qualification Data: Certificates, for commercial domestic-water heaters, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: For each type of commercial, electric, domestic-water heater.

D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranty: For special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include emergency, operation, and maintenance manuals.

1.07 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.08 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including storage tank and supports.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Periods: From date of Substantial Completion.
      a. Commercial, Electric, Domestic-Water Booster Heaters:
         1) Controls and Other Components Five years.
      b. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
         1) Storage Tank: Five years.
         2) Controls and Other Components: Three years.
      c. Expansion Tanks: Five years.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.02 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Domestic-Water Booster Heaters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A. O. Smith Corporation.
      b. Electric Heater Company (The).
      c. Bradford White.
      d. Lochinvar, LLC.
      e. Rheem Manufacturing Company.
      f. Ruud Water Heaters; a Rheem brand.
   2. Source Limitations: Obtain domestic-water booster heaters from single source from single manufacturer.
   3. Standard: UL 1453.

4. Tank Construction: steel.
    a. Tappings: ASME B1.20.1 pipe thread.
    b. Pressure Rating: 150 psig (1034.21 kPa).
    c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
5. Factory-Installed Tank Appurtenances:
    a. Anode Rod: Replaceable magnesium.
    b. Drain Valve: Corrosion-resistant metal with hose-end connection.
    c. Insulation: Comply with ASHRAE/IES 90.1.
    d. Jacket: Rectangular shaped, with stainless steel front panel, unless otherwise indicated.
    e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
        1) Option: Booster heaters with total of 9 kW or less may have one, two, or three elements.
    f. Temperature Control: Adjustable thermostat, to setting of at least 180 deg F.
    g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
    h. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valve. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.
    i. Gauges: Combination temperature-and-pressure type or separate thermometer and pressure gauge.
6. Special Requirements: NSF 5 construction with brackets for undercounter, or legs for floor installation.

2.03 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. A. O. Smith Corporation.
        b. AMTROL, Inc.
        c. Flexcon Industries.
        d. Honeywell.
        e. Pentair Pump Group.
        f. State Industries.
        g. TACO Comfort Solutions, Inc.
    2. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
    3. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.
    4. Construction:
        a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
        b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
        c. Air-Charging Valve: Factory installed.
B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1

D. Heat-Trap Fittings: ASHRAE/IES 90.1.

E. Manifold Kits: Domestic-water-heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and calibrated balancing valves to provide balanced flow through each domestic-water heater.
   1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
   2. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."

F. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig-maximum outlet pressure unless otherwise indicated.

G. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.

H. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than working-pressure rating of domestic-water heater.

I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

J. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of 18 inches (457.2 mm) above the floor.

L. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.04 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."
   1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
   2. Maintain manufacturer's recommended clearances.
   3. Arrange units so controls and devices that require servicing are accessible.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping."

C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install combination temperature and pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves .

F. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers.

G. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

H. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

I. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

J. Fill electric, domestic-water heaters with water.

K. Charge domestic-water expansion tanks with air to required system pressure.

L. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

3.02 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.03 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

F. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.05 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial electric, domestic-water heaters. Training shall be a minimum of one hour(s).

END OF SECTION

SECTION 224713
DRINKING FOUNTAINS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997 (Reaffirmed 2017).

B. ASME A112.18.2 - Plumbing Waste Fittings; 2020 (Reaffirmed 2025).

C. ASME A112.19.3 - Stainless Steel Plumbing Fixtures; 2022.

D. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. NSF 42 - Drinking Water Treatment Units – Aesthetic Effects; 2025.

H. NSF 53 - Drinking Water Treatment Units – Health Effects; 2025.

I. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum

J. NSF 372 - Drinking Water System Components - Lead Content; 2024.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. Section Includes:
   1. Drinking fountains.
   2. Bottle filling stations.
   3. Supports.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of drinking fountain and bottle filling station.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include operating characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

C. Shop Drawings:
   1. Include diagrams for power wiring.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance Data: For drinking fountains and bottle filling stations to include in maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filter Cartridges: Equal to 100 percent of quantity installed for each type and size indicated.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Standards:

1. Drinking fountains and bottle filling stations intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
2. Comply with ASME A112.19.3/CSA B45.4 for stainless steel drinking fountains and bottle filling stations.
3. Comply with NSF 42 and NSF 53 for water filters for drinking fountains and bottle filling stations.
4. Comply with ICC A117.1 for accessible drinking fountains and bottle filling stations.

2.02 DRINKING FOUNTAINS

A. Insert drawing designation. Use these designations on Drawings to identify each drinking fountain.

B. Insert drawing designation. Use these designations on Drawings to identify each drinking fountain.

C. Drinking Fountains - Surface Wall-Mounted, Stainless Steel.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elkay.
      b. Filtrine Manufacturing Company.
      c. Halsey Taylor.
      d. Haws Corporation.
      e. Most Dependable Fountains, Inc.
      f. Oasis International.
   2. Source Limitations: Obtain surface wall-mounted, stainless steel drinking fountains from single source from single manufacturer.
   3. Type: Vandal resistant.
   4. Receptor(s):
      a. Type: On horizontal support.
      b. Shape: Rectangular.
      c. Back Panel:[Stainless steel wall plate behind drinking fountain.
      d. Bubblers: One for each receptor, with adjustable stream regulator, located on deck.
      e. Drain: Grid type with NPS 1-1/4 tailpiece.
   5. Maximum Water Flow: 0.5 gpm.
   6. Control: Push bar.
   7. Supply: NPS 3/8 with shutoff valve.
   8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 chrome-plated brass P-trap and waste.
   9. Filter: One or more water filters with capacity sized for unit peak flow rate.
   10. Electrical Characteristics:
      a. Volts: 120 V ac.
      b. Phase: Single.
      c. Hertz: 60 Hz.
   11. Support: Provide manufacturer's mounting plate and drinking fountain carrier.
   12. Drinking Fountain Mounting Height: Accessible in accordance with ICC A117.1 High/low - standard/accessible in accordance with ICC A117.1.
   13. Freeze-Resistant Supply Fittings: Through wall freeze-resistant shutoff and flow-control valve assembly.

D. Insert drawing designation. Use these designations on Drawings to identify each drinking fountain.

E. Insert drawing designation. Use these designations on Drawings to identify each bottle filling station.

F. Bottle Filling Station - Surface Wall-Mounted, Stainless Steel:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elkay.
      b. Halsey Taylor.
      c. Most Dependable Fountains, Inc.
      d. Murdock Manufacturing; A Division of Morris Group International.
   2. Source Limitations: Obtain surface wall-mounted, stainless steel, bottle filling stations from single source from single manufacturer.
   3. Type: Vandal resistant.
   4. Cabinet: Stainless steel.
   5. Bottle Filler: Push-button activation[, with 20-second automatic shutoff timer. Fill rate 0.5 to 1.5 gpm.
   6. Drain: Grid type with NPS 1-1/4 tailpiece.
   7. Supply: NPS 3/8 with shutoff valve.
   8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
   9. Filter: One or more water filters complying with NSF 42 and NSF 53 and with capacity sized for peak flow rate.
   10. Support: Provide manufacturer's mounting plate and drinking fountain carrier.
   11. Bottle Filling Station Mounting Height: Accessible in accordance with ICC A117.1.
   12. Electrical Characteristics:
      a. Volts: 120 V ac.
      b. Phase: Single.
      c. Hertz: 60 Hz.

2.03 SUPPORTS

A. Drinking Fountain Carrier:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company.
      b. MIFAB, Inc.
      c. Wade Drains.
      d. WATTS.
      e. Zurn Industries, LLC.
      f. Standard: ASME A112.6.1M.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Set pedestal drinking fountains and bottle filling stations on flat surface in accordance with manufacturer's written installation instructions.

C. Install recessed, drinking fountains and bottle filling stations secured to wood blocking in wall construction.

D. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping.

F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.03 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball shutoff valve on water supply to each fixture. Install valve upstream from filter for drinking fountain. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping.

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.04 ELECTRICAL CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplates to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
   2. Nameplates to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (12.7 mm) high.

3.05 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

3.06 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 230500
COMMON WORK RESULTS FOR HVAC

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

3.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. All HVAC and plumbing work shall comply with applicable codes, industry standards, and local ordinances such as ASME, ASPE, ASTM, NFPA, and ASHRAE.

3.02 SUMMARY

A. This Section includes the following:
   1. Equipment installation requirements common to equipment sections.
   2. Painting and finishing.
   3. Supports and anchorages.

3.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   1. CPVC: Chlorinated polyvinyl chloride plastic.
   2. PE: Polyethylene plastic.
   3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM:Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

3.04 SUBMITTALS

3.05 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

3.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

3.07 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Prepare Coordination / Installation Shop drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
   1. Structural floor, wall and roof opening sizes and details.
   2. Clearances for installing and maintaining insulation.
   3. Locations of light fixtures and sprinkler heads.
   4. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
   5. Equipment connections and support details.
   6. Exterior wall and foundation penetrations.
   7. Routing of sanitary sewer piping.
   8. Fire-rated wall and floor penetrations.

PART 2 PRODUCTS

4.01 SCOPE OF SERVICES

A. Base bid includes Mechanical (HVAC), and Plumbing work as shown and described in the contract documents. Work will have to be done in a staged manner to allow continuous use of the balance of the facility by the building occupants. Refer to architectural staging criteria.

B. This Division requires the furnishing and installing of all items Specified herein, indicated on the Drawings or reasonably inferred as necessary for safe and proper operation; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, transportation, storage, equipment, utilities, all required permits, licenses and inspections. All work performed under this Section shall be in accordance with the Project Manual, Drawings and Specifications and is subject to the terms and conditions of the Contract.

C. The approximate locations of Mechanical (HVAC) and Plumbing items are indicated on the Drawings. These Drawings are not intended to give complete and accurate details in regard to location of outlets, apparatus, etc. Exact locations are to be determined by actual

measurements at the building, and will in all cases be subject to the Review of the Owner or Engineer, who reserves the right to make any reasonable changes in the locations indicated without additional cost to the Owner.

D. Items specifically mentioned in the Specifications but not shown on the Drawings and/or items shown on Drawings but not specifically mentioned in the Specifications shall be installed by the Contractor under the appropriate section of work as if they were both specified and shown.

E. All discrepancies between the Contract Documents and actual job-site conditions shall be reported to the Project Manager or Engineer so that they will be resolved prior to the bidding, where this cannot be done at least 7 working days prior to bid; the greater or more costly of the discrepancy shall be bid. All labor and materials required to perform the work described shall be included as part of this Contract.

F. It is the intention of this Section of the Specifications to outline minimum requirements to furnish the Owner with a turn-key and fully operating system in cooperation with other trades.

4.02 APPILCABLE CODES

A. Obtain all required permits and inspections for all work required by the Contract Documents and pay all required fees in connection thereof.

B. Arrange with the serving utility companies for the connection of all required utilities and pay all charges, meter charges, connection fees and inspection fees, if required.

C. Comply with all applicable codes, specifications, local ordinances, industry standards, utility company regulations and the applicable requirements of the following nationally accepted codes and standards:
   1. Underwriters' Laboratories, Inc., UL.
   2. Air Moving & Conditioning Association, AMCA.
   3. American Standards Association, ASA.
   4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., ASHRAE.
   5. American Society of Mechanical Engineers, ASME.
   6. American Society of Plumbing Engineers, ASPE.
   7. American Society of Testing Materials, ASTM.
   8. American Water Works Association, AWWA.
   9. National Bureau of Standards, NBS.
   10. National Fire Protection Association, NFPA.
   11. Sheet Metal & Air Conditioning Contractors' National Association, SMACNA.

D. Where differences existing between the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, the more stringent or costly application shall govern. Promptly notify the Engineer in writing of all differences.

E. When directed in writing by the Engineer, remove all work installed that does not comply with the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above-mentioned nationally accepted codes and standards, correct the deficiencies, and complete the work at no additional cost to the Owner.

4.03 DRAWINGS & SPECIFICATIONS

A. These Specifications are intended to supplement the Drawings and it will not be the province of the Specifications to mention any part of the work which the Drawings are competent to fully explain in every particular and such omission is not to relieve the Contractor from carrying out portions indicated on the Drawings only.

B. Should items be required by these Specifications and not indicated on the Drawings, they are to be supplied even if of such nature that they could have been indicated thereon. In case of disagreement between Drawings and Specifications, or within either Drawings or Specifications, the better quality or greater quantity of work shall be estimated and the matter referred to the Architect or Engineer for review with a request for information and clarification at least 7 working days prior to bid opening date for issuance of an addendum.

C. The listing of product manufacturers, materials and methods in the various sections of the Specifications, and indicated on the Drawings, is intended to establish a standard of quality only. It is not the intention of the Owner or Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturers' standard product will meet the requirements of the project design, Drawings, Specifications and space constraints.

D. The Architect or Engineer and Owner shall be the sole judge of quality and equivalence of equipment, materials and methods.

E. Products by other reliable manufacturers, other materials, and other methods, will be accepted as outlined, provided they have equal capacity, construction, and performance. However, under no circumstances shall any substitution by made without the written permission of the Architect or Engineer and Owner. Request for prior approval must be made in writing 10 days prior to the bid date with out fail.

F. Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method is the only one that shall be used without prior approval.

G. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be substituted, it is the intention of the Owner or Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without approval.

H. Wherever a definite product, material or method is specified and there is a statement that "OR EQUAL" product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method or an "OR EQUAL" product, material or method may be used if it complies with the specifications and is submitted for review to the Engineer as outline herein. Where permission to use substituted or alternative equipment on the project is granted by the Owner or Engineer in writing, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available which includes allowances for all required Code and maintenance clearances, and to coordinate all equipment structural support, plumbing and electrical requirements and provisions with the Mechanical (HVAC) and Plumbing Design Documents and all other trades.

I. Coordinate with Division 1 requirements for substitution, unless noted otherwise the Contractors wishing to substitute products, materials or methods from those indicated or specified, shall submit such requests to the Owner or Engineer in writing and within THIRTY (30) WORKING DAYS OF NOTIFICATION OF CONTRACT AWARD. Requests for permission to utilize alternates or substitutions will not be considered after that time, unless the Specified item is unavailable or will adversely affect completion of the Project. Claims submitted for consideration will require notarized letters from all parties involved and will be considered only if the Contractor has been timely in his delivery for review of all required equipment and material submittals. Owner or Engineer will investigate such requests for substitution and if acceptable will issue a letter allowing the substitution.

J. If any request for a substitution of a product, material or method is rejected, the Contractor will automatically be required to furnish the product, material or method named in the Specifications. Repetitive requests for substitutions will not be considered.

K. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop Drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks' time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

L. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop Drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the Specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

M. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

N. Requests shall be bound and shall consist of three (3) sets of descriptive literature and performance data covering each item of equipment or material. The submittal shall include the following:
   1. Name of the individuals or company originating the submittal.
   2. Name of the project for which the submittal is made.
   3. An index page of the items submitted.
   4. A written list of variations between the specified product and the submitted product.
   5. Sufficient information, including scaled drawing of area and equipment involved at a scale of 1/4" = 1'-0" minimum, as required to demonstrate that the alternate or substituted product will fit in the space available.
   6. Identification of each item of material or equipment matching that indicated on the Drawings. All applicable industry or national Listings, Labels, Approvals and Standards shall be clearly indicated.
   7. Sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Drawings and Specifications. Any options or special requirements shall be so indicated. All non-applicable information shall be crossed out.
   8. Provide upon request of the Owner or Engineer, samples of materials and/or equipment as may be required.

O. The Owner or Engineer will investigate all requests for substitutions when submitted in accordance with above and if accepted, will issue a letter allowing the substitutions. The Engineer shall be the sole authority to approve or disapprove any and all substitutions.

P. Where equipment other than that used in the design as specified or shown on the Drawings is substituted (either from an approved manufacturers list or by submittal review), it shall be the responsibility of the substituting Contractor to coordinate space requirements, building provisions and connection requirements with his trades and all other trades and pay all additional costs to other trades, the Owner, the Architect or Engineer, if any, due to the substitutions.

4.04 RECORD DOCEMENTS

A. Prepare record documents in accordance with the requirements in Special Project Requirements, in addition to the requirements specified in Division 23, indicate the following installed conditions.
   1. Duct mains and branches, size and location, for both exterior and interior; locations of dampers, fire dampers, duct access panels, and other control devices; filters, fuel fired heaters, fan coils, condensing units, and roof-top A/C units requiring periodic maintenance or repair.
   2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
   3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
   4. Contract Modifications, actual equipment and materials installed.

B. The Contractor shall maintain a set of clearly marked black line record "AS-BUILT" prints on the job site on which he shall mark all work details, alterations to meet site conditions and changes made by "Change Order" notices. These shall be kept available for inspection by the Owner, Architect or Engineer at all times.

C. Refer to Division 1 for additional requirements concerning record drawings. If the Contractor does not keep an accurate set of as-built drawings, the pay request may be altered or delayed at the request of the Architect. Mark the drawings with a colored pencil. Delivery of as-built prints and re-producible is a condition of final acceptance.

D. The record prints shall be updated on a daily basis and shall indicate accurate dimensions for all buried or concealed work, precise locations of all concealed pipe or duct, locations of all concealed valves, controls and devices and any deviations from the work shown on the Construction Documents which are required for coordination. All dimensions shall include at least two dimensions to permanent structure points.

E. At the Engineer's option, the Contractor shall transfer all data from the record "AS-BUILT" prints to an electronic media such as AutoCAD latest release, in order to plot the reproducible media "AS-BUILT" drawings. Since data stored on electronic media can deteriorate undetected or be modified without the Engineer's knowledge, the AutoCAD electronic drawing files are provided without warranty or obligation on the part of the Engineer as to accuracy or information contained in the files. All information in the files shall be independently verified by the user. Any user shall agree to indemnify and hold the Engineer harmless from any and all claims, damages, losses, and expenses including but not limited to Attorney's fees arising out of the use of the AutoCAD drawing files. Engineer shall furnish to the Contractor electronic media files of Contract Documents for the Contractor to use for inputting of the data from the record "AS-BUILT" prints and the Contractor shall return the revised electronic files on CD ROM properly labeled to the Engineer and shall submit the plotted reproducible drawings and three (3) sets of black line prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineers Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet as described in paragraph F. below.

F. As part the work, the Contractor shall transfer all marks from the submit a set of clear concise set of reproducible record "AS-BUILT" drawings and shall submit the reproducible drawings with corrections made by a competent draftsman and three (3) sets of black line prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineers Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet.

G. No retainage shall be released until COH has received all Operations and Maintenance manuals, keys, record drawings, and warranty certificates.

4.05 OPERATION AND MAINTENANCE MANUALS

A. In addition to the above, the Contractor shall accumulate during the progress of the job the following data, in duplicate, prepared in a neat brochure or packet folder and turn over to the Architect/Engineer for review, and subsequent delivery to the Owner.
   1. All warranties and guarantees and manufacturers' directions on equipment and material covered by the Contract.
   2. Two sets of operating instructions for heating and cooling and other mechanical and electrical systems. Operating instructions shall also include recommended preventative maintenance and seasonal changeover procedures.
   3. Approved wiring diagrams and control diagrams representing "as installed" conditions.
   4. Copies of approved Shop Drawings.
   5. Any and all other data and/or drawings required as submittals during construction.
   6. Repair parts list of all major items and equipment.
   7. As-built record drawings.

B. O & M manuals shall also provide the following information.
   1. All equipment sizes and selected options.
   2. Operation instructions for each piece of equipment requiring maintenance with actions clearly identified.
   3. Name, address, telephone numbers and e-mail address of local supplier or agent.
   4. Web site address of each manufacturer.
   5. HVAC controls system maintenance information.
   6. A complete narrative on how each system is intended to operate.

PART 3 EXECUTION

5.01 HVAC DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

5.02 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

5.03 CONNECTIONS FOR OTHERS

A. The Mechanical Contractor shall rough in for and make all gas, water, steam, sewer, etc. connections to all fixtures, equipment, machinery, etc., provided by others in accordance with detailed roughing-in Drawings provided by the equipment suppliers, by actual measurements of the equipment connections, or as detailed.

B. After the equipment is set in place, this Contractor shall make all final connections and shall provide all required pipe, fittings, valves, traps, etc.

C. Provide all air gap fittings required, using materials hereinbefore specified. In each service line connected to an item of equipment or piece of machinery, provide a shutoff valve. On each drain not provided with a trap, provide a suitable trap.

D. All pipe fittings, valves, traps, etc., exposed in finished areas and connected to chrome plated lines provided by others shall be chrome plated to match.

E. Provide all sheet metal ductwork, transition pieces, etc., required for a complete installation of vent hoods, fume hoods, etc., provided by others.

5.04 CUTTING AND PATCHING

A. General: Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.

B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., shall be core drilled to exact size.

C. Restoration:All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

E. Plaster: All mechanical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.

5.05 ACCESS DOORS

A. General: This Contractor shall provide wall or ceiling access doors for unrestricted access to all concealed items of mechanical equipment or devices.

B. Doors: Access doors mounted in painted surfaces shall be of Milcor (Inland-Ryerson Construction Products Company) manufacture, Style K for plastered surfaces and Style M or DW for non-plastered surfaces. The Style K doors shall be set so that the finished surface of the door is even with the finished surface of the adjacent finishes. Access doors mounted on tile surfaces shall be of similar construction as noted above, except they shall be of stainless steel materials. Access doors shall be a minimum of 12" x 12" in size.

5.06 ROOF PENETRATIONS AND FLASHING

A. Pipe, conduit and duct sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided and installed by a qualified contractor for all roof penetrations. This shall be the responsibility of the General Contractor.

5.07 EXCAVATION, TRENCHING AND BACKFILL

A. The Mechanical and Electrical subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the Drawings and/or required for the installation of piping, conduit, utility systems, etc. All exterior lines shall be installed with a minimum cover of 24", unless otherwise indicated. Generally, more cover shall be provided if grade will permit. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced. Trenches shall be not less than 12" wider nor more than 16" wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6" nor more than 8" in width is provided on each side of the pipe. For sewers, the maximum width of trench specified applies to the width at and below the level may be made as wide as necessary for sheeting and bracing, and the proper installation of the work.

B. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes shall be dug after the trench

bottom has been graded. Where inverts are not shown, grading shall be determined by the National Plumbing Code for the service intended and the size used. Bell holes for lead pipe joints shall be 12" in depth below the trench bottom and shall extend from a point 6" back of the face of the bell. Such bell holes shall be of sufficient width to provide ample room for caulking. Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to insure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used. In general, grading for electrical duct banks and conduits shall be from building to manhole, and from a high point between manholes to each manhole. Special pipe beds shall be provided as specified hereinafter.

C. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by men especially skilled in this type of work. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required. Where rock excavation is required, the rock shall be excavated to a minimum over depth of 6" below the trench depths specified. The over depth rock excavation and all excess trench excavation shall be backfilled with sand. Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.

D. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the job site as directed by the Construction Inspector.

E. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided.

F. Excavate as required under the building in order that all piping, ductwork, etc., shall clear the ground a minimum of 12" for a distance of 24" on either side. Edges of such excavations shall slope at an angle of not over 45 degrees with the horizontal unless otherwise approved by the Construction Inspector. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.

G. Trenches for cast iron drain, storm water and sewer lines inside the building shall be properly excavated, following, in general, the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped and settled with water. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.

H. All surplus materials removed in these trenching operations becomes the property of the contractor, and shall be disposed of at the expense of the contractor, at a legal disposal site, off of the project site.

I. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches (304.8 mm) above the top of the pipe. The next layer and subsequent layers of backfill may be excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clouds of earth or stones larger than 1 1/2" in diameter, flooded until the pipe has cover of not less than one foot. The remainder of the backfill material shall then be thrown into the trenches, moistened, and tamped or flooded in one-foot layers. Blasted rock, broken concrete or pavement, and large boulders shall not be used as backfill material. Any trenches improperly

backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and mounded over, and smoothed off.

J. Backfill under concrete slabs-on-fill shall be as specified above, shall be gravel, or shall be other such materials more suitable for the application. Installation and compaction shall be as required for compatibility with adjacent materials.

K. Opening and Re-closing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched, using materials to match those cut out. The patches shall thoroughly bond with the original surfaces and shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas.

5.08 OPERATION PRIOR TO COMPLETION

A. When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Construction Inspector's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

5.09 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT

A. Before the work is accepted, an authorized representative of the manufacturer of the installed materials and/or equipment shall personally inspect the installation and operation of his materials and/or equipment to determine that it is properly installed and in proper operating order. The qualifications of the representative shall be appropriate to the technical requirements of the installation. The qualifications of the representative shall be submitted to the owner for approval. The decision of the owner concerning the appropriateness of the representative shall be final. Testing and checking shall be accomplished during the course of the work where required by work being concealed, and at the completion of the work otherwise. In addition, the Contractor shall submit to the Architect/Engineer a signed statement from each representative certifying as follows: "I certify that the materials and/or equipment listed below have been personally inspected by the undersigned authorized manufacturer's representative and is properly installed and operating in accordance with the manufacturer's recommendations".

B. Check inspections shall include plumbing equipment, heating, air conditioning, insulation, ventilating equipment, controls, mechanical equipment and such other items hereinafter specified or specifically designated by the Architect/Engineer.

C. The Contractor shall make, at no additional cost to the Owner, any tests deemed necessary by the inspection departments having jurisdiction, and in the National Fire Protection Association, ASTM, etc. Standards listed. The Contractor shall provide all equipment, materials, and labor for making such tests. Reasonable amounts of fuel and electrical energy costs for system tests will be paid by the Owner. Fuel and electrical energy costs for system adjustment and tests which follow beneficial occupancy by the Owner will be borne by the Owner.

D. Additional tests specified hereinafter under the various Specification Sections shall be made.

E. The Construction Inspector shall be notified in writing at least 10 working days prior to each test and other Specification requirements requiring action on the part of the Construction Inspector.

All equipment shall be placed in operation and tested for proper automatic control requirements before the balancing agency starts their work.

5.10 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. All equipment, piping, conduit, ductwork, grilles, insulation, etc., furnished and installed in exposed areas under Divisions 22, 23 and 26 of these Specifications and as hereinafter specified shall be cleaned, prepared, and painted according to the following specification. In the event of a conflict between the specifications referenced, the provisions of this specification shall prevail only for Division 22, 23 and Division 26 work.

C. All purchased equipment furnished by the mechanical and electrical subcontractors shall be delivered to the job with a suitable factory protective finish with the colors hereinafter specified. The following materials shall not be painted: copper, galvanized metal, stainless steel, fiberglass, PVC, and PVDF.

D. Before painting, materials and equipment surfaces shall be thoroughly cleaned of cement, plaster, and other foreign materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metal work shall be carefully brushed down with the steel brushes to remove rust and other spots and left smooth and clean.

E. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

5.11 PIPE PRESSURE TESTS

A. The following lines shall be tested at the stated pressure for the length of time note.

B. Where leaks occur, the pipe shall be repaired and the tests repeated. No leaks shall be corrected by peening. Defective piping and joints shall be removed and replaced.

1. TESTING TESTING PRESSURE TIME IN SERVICE MEDIUM (PSIG) HOURS
    a. Domestic Hot & Cold Water Water 150 24
    b. Sanitary & Storm Piping Water Fill to top 24
    c. Natural Gas Air 100 24
    d. Compressed Air Air 225 24

5.12 TRAINING

A. The contractor shall provide manufacturer’s orientation training to the college maintenance personnel on the HVAC and plumbing systems.

END OF SECTION

SECTION 230513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.03 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (100584 cm) above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factors.

2.03 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficiency, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Re-greasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in a motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
   2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.05 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 230517
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

SECTION 23 05 17

SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL

3.01 REFERENCE STANDARDS

A. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).

B. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2026.

3.02 SUMMARY

A. Section Includes:
   1. Sleeves.
   2. Sleeve-seal systems.
   3. Grout.
   4. Silicone sealants.

B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

3.03 SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

4.01 SLEEVES

A. Galvanized-Steel Sheet Pipe Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

4.02 SLEEVE-SEAL SYSTEMS

A. Description:
   1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   2. Designed to form a hydrostatic seal of 20-psig (137-kPa) minimum).
   3. Sealing Elements: EPDM-rubber or Nitrile (Buna N) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
   4. Pressure Plates: Stainless steel.
   5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

4.03 GROUT

A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

4.04 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, use NT.

PART 3 EXECUTION

5.01 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. Core drill holes in existing walls as required for sleeve installations.

C. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

D. Cut sleeves to length for mounting flush with exposed surfaces. Seal annular space with grout or silicone.

E. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.

F. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

5.02 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

5.03 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

END OF SECTION

SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASME B31.9 - Building Services Piping; 2025.

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2026.

D. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.

E. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.

F. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2026.

G. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).

H. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

I. SSPC-PA 1 - Shop, Field, and Maintenance Coating of Metals; 2024, with Errata (2025).

1.02 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Thermal-hanger shield inserts.
   4. Fastener systems.

1.03 SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
   3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe and Tube Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel.

2.02 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.03 THERMAL-HANGER SHIELD INSERTS

A. Provide insulation-insert material for support of uninsulated cold piping:

B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

D. Insert Length: Extend 2 inches (50.8 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.04 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.05 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.06 MATERIALS

A. Carbon Steel: ASTM A1011/A1011M.

B. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

C. Stainless Steel: ASTM A240/A240M.

D. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 EXECUTION

3.01 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

3.02 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (101.6 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (304.8 mm) long and 0.048 inch (1.22 mm) thick.
   5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (38 mm).

3.05 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils 0 inch (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.06 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use corrosion-resistant hangers, supports, and attachments for exterior applications.

G. Use copper-plated pipe hangers and attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
   2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (101.6 mm) of insulation.
   3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
   4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.

5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
11. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (152.4 mm) for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
   4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
   5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
   3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   6. C-Clamps (MSS Type 23): For structural shapes.
   7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
   8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
   9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
    2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
    3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
    2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
    3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
    4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
    5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
    6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
    7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
    8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
        a. Horizontal (MSS Type 54): Mounted horizontally.
        b. Vertical (MSS Type 55): Mounted vertically.
        c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors where required in concrete construction.

END OF SECTION

SECTION 230548
VIBRATION CONTROLS FOR HVAC

SECTION 23 05 48

VIBRATION CONTROLS FOR HVAC

PART 1 GENERAL

3.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

3.02 SUMMARY

A. Section Includes:
   1. Elastomeric isolation pads.
   2. Elastomeric isolation mounts.
   3. Restrained elastomeric isolation mounts.
   4. Open-spring isolators.
   5. Housed-spring isolators.
   6. Restrained-spring isolators.
   7. Housed-restrained-spring isolators.
   8. Pipe-riser resilient support.
   9. Resilient pipe guides.
   10. Air-spring isolators.
   11. Restrained-air-spring isolators.
   12. Elastomeric hangers.
   13. Spring hangers.
   14. Snubbers.
   15. Restraints - rigid type.
   16. Restraints - cable type.
   17. Restraint accessories.
   18. Post-installed concrete anchors.
   19. Concrete inserts.
   20. Vibration isolation equipment bases.
   21. Restrained isolation roof-curb rails.

B. Related Requirements:
   1. Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
   2. Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

3.03 DEFINITIONS

A. IBC: International Building Code.

B. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

3.04 REFERENCE STANDARDS

A. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

C. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

D. ASTM A492 - Standard Specification for Stainless Steel Rope Wire; 1995 (Reapproved 2019).

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

F. ASTM E488/E488M - Standard Test Methods for Strength of Anchors in Concrete Elements; 2022.

G. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).

H. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

I. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

3.05 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Include load rating for each wind-force-restraint fitting and assembly.
   3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and wind-force-restraint component.
   4. Annotate to indicate application of each product submitted and compliance with requirements.
   5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:
   1. Detail fabrication and assembly of equipment bases.
   2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:
   1. For each wind-load protection device that is required by this Section or is indicated on Drawings, submit the following:
      a. Vibration Isolator and Wind-Load-Restraint Selection: Select vibration isolators, wind-load restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
      b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
      c. Concrete Anchors and Inserts: Include calculations showing anticipated wind loads.
      d. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
      e. Qualified Professional Engineer: All designated-design submittals for wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
   2. Wind-Restraint Detail Drawing:
      a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
      b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values

of forces transmitted to the structure during wind events. Indicate association with vibration isolation devices.

c. Coordinate vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

3. All delegated-design submittals for wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
4. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and basis for approval (tests or calculations).
5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

3.06 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints.

B. Qualification Data: For testing agency.

C. Welding certificates.

D. Air-Spring Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.

E. Field quality-control reports.

F. Wind-Force Performance Certification: Provide special certification for HVAC components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.

1. Provide equipment manufacturer's written certification for each designated HVAC device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
2. Provide manufacturer's written certification for each designated louver, damper, or similar device, stating that it will remain in place and protect opening from penetration of windborne debris and comply with all requirements of authorities having jurisdiction.
3. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.
4. The following HVAC systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind force and impact damage must be provided by manufacturer:
   a. DOAS, OAHU, LEF.

3.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-spring mounts and restrained-air-spring mounts to include in operation and maintenance manuals.

3.08 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an agency acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

4.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design system.
   1. Wind-Load Performance: Equipment shall withstand the effects of high wind events determined in accordance with ASCE/SEI 7-10.

B. Wind-Load Design Calculations:
   1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-10 Insert ASCE/SEI 7 edition or other wind-force calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.
      a. Factors indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
      b. Coordinate design wind-load calculations with vibration isolation requirements. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
   2. Design wind pressure "p" for external sidewall-mounted equipment such as louvers is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:
      a. PART 1: Low-Rise Buildings.
      b. PART 2: Low-Rise Buildings (Simplified).
      c. PART 3: Buildings with "h" less than 60 feet (1828.8 cm).
      d. PART 4: Buildings with "h" greater than 60 feet (1828.8 cm) and less than 160 feet.
      e. PART 5: Open Buildings.
   3. Design wind pressure "p" for external sidewall-mounted equipment such as louvers are to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:
      a. PART 1: Low-Rise Buildings.
      b. PART 2: Low-Rise Buildings (Simplified).
      c. PART 3: Buildings with "h" greater than 60 feet (1828.8 cm).
      d. PART 4: Buildings with "h" less than 160 feet (4876.8 cm).
      e. PART 5: Open Buildings.
   4. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment. Delegated-Design Contractor is to coordinate and verify the given values below with the Architect and the structural Engineer.
      a. Risk Category: III.
      b. h = Mean roof height: 16’ 0”.
      c. V = Basic Wind Speed: 145 MPH.
      d. Kd = Wind Directionality Factor: 0.85.

e. Exposure Category.
f. Kzt = Topographic Factor.
g. Kz = Velocity Pressure Exposure Coefficient (Evaluated at Height z).
h. Kh = Velocity Pressure Exposure Coefficient (Evaluated at Height h).
i. qz = Velocity Pressure at Height z: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
j. qh = Velocity Pressure at Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
k. G = Gust-Effect Factor: 0.85.
l. Enclosure Classification.
m. GCpi = Internal Pressure Coefficient.

C. Consequential Damage: Provide additional restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in ASCE/SEI 7-10 so that failure of a non-essential or essential HVAC component will not cause the failure of any other essential architectural, mechanical, or electrical building component.

D. Fire/Smoke Resistance: All components that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:
1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

4.02 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: .
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Ace Mountings Co., Inc.
b. CADDY; nVent.
c. California Dynamics Corporation.
d. Isolation Technology, Inc.
e. Kinetics Noise Control, Inc.
f. Korfund.
g. Mason Industries, Inc.
h. Novia; A Division of C&P.
i. Vibration Eliminator Co., Inc.
j. Vibration Isolation.
k. Vibration Management Corp.
l. Vibration Mountings & Controls, Inc.
2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Minimum deflection as indicated on Drawings.
5. Pad Material: Oil- and water-resistant rubber.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric.
a. Infused nonwoven cotton or synthetic fibers.

4.03 ELASTOMERIC ISOLATION MOUNTS

A. Elastomeric Isolation Mounts: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ace Mountings Co., Inc.
   b. CADDY; nVent.
   c. California Dynamics Corporation.
   d. Isolation Technology, Inc.
   e. Kinetics Noise Control, Inc.
   f. Korfund.
   g. Mason Industries, Inc.
   h. Novia; A Division of C&P.
   i. Vibration Eliminator Co., Inc.
   j. Vibration Isolation.
   k. Vibration Management Corp.
   l. Vibration Mountings & Controls, Inc.
2. Mounting Plates:
   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Minimum deflection as indicated on Drawings.
4. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

4.04 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts: .
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ace Mountings Co., Inc.
      b. CADDY; nVent.
      c. California Dynamics Corporation.
      d. Isolation Technology, Inc.
      e. Kinetics Noise Control, Inc.
      f. Korfund.
      g. Mason Industries, Inc.
      h. Novia; A Division of C&P.
      i. Vibration Eliminator Co., Inc.
      j. Vibration Isolation.
      k. Vibration Management Corp.
      l. Vibration Mountings & Controls, Inc.
   2. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
      a. Housing: Cast-ductile iron or welded steel.
      b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.
   3. Minimum deflection as indicated on Drawings.

4.05 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators: .
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ace Mountings Co., Inc.
      b. CADDY; nVent.

c. California Dynamics Corporation.
d. Isolation Technology, Inc.
e. Kinetics Noise Control, Inc.
f. Korfund.
g. Mason Industries, Inc.
h. Novia; A Division of C&P.
i. Vibration Eliminator Co., Inc.
j. Vibration Isolation.
k. Vibration Management Corp.
l. Vibration Mountings & Controls, Inc.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psi (3447.38 kPa).
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
8. Minimum deflection as indicated on Drawings.

4.06 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing: .
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Ace Mountings Co., Inc.
b. CADDY; nVent.
c. California Dynamics Corporation.
d. Isolation Technology, Inc.
e. Kinetics Noise Control, Inc.
f. Korfund.
g. Mason Industries, Inc.
h. Vibration Eliminator Co., Inc.
i. Vibration Isolation.
j. Vibration Management Corp.
k. Vibration Mountings & Controls, Inc.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum deflection as indicated on Drawings.
7. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi (3447.38 kPa).
b. Top housing with threaded mounting holes and internal leveling device.

4.07 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ace Mountings Co., Inc.
   b. CADDY; nVent.
   c. California Dynamics Corporation.
   d. Isolation Technology, Inc.
   e. Kinetics Noise Control, Inc.
   f. Korfund.
   g. Mason Industries, Inc.
   h. Novia; A Division of C&P.
   i. Vibration Eliminator Co., Inc.
   j. Vibration Isolation.
   k. Vibration Management Corp.
   l. Vibration Mountings & Controls, Inc.
2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
   a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi (3447.38 kPa).
   b. Top plate with elastomeric pad.
   c. Internal leveling bolt that acts as blocking during installation.
3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Minimum deflection as indicated on Drawings.

4.08 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing: .
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ace Mountings Co., Inc.
      b. CADDY; nVent.
      c. California Dynamics Corporation.
      d. Isolation Technology, Inc.
      e. Kinetics Noise Control, Inc.
      f. Korfund.
      g. Mason Industries, Inc.
      h. Vibration Eliminator Co., Inc.
      i. Vibration Isolation.
      j. Vibration Management Corp.
      k. Vibration Mountings & Controls, Inc.
   2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
      a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi (3447.38 kPa).
      b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Minimum deflection as indicated on Drawings.

4.09 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch-Thick Neoprene: .
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. California Dynamics Corporation.
      b. Kinetics Noise Control, Inc.
      c. Mason Industries, Inc.
      d. Vibration Eliminator Co., Inc.
      e. Vibration Management Corp.
   2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
   3. Maximum Load Per Support: 500 psi (3447.38 kPa) on isolation material providing equal isolation in all directions.
   4. Minimum deflection as indicated on Drawings.

4.10 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch-Thick Neoprene: .
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. California Dynamics Corporation.
      b. Kinetics Noise Control, Inc.
      c. Mason Industries, Inc.
      d. Vibration Eliminator Co., Inc.
      e. Vibration Management Corp.
      f. Vibration Mountings & Controls, Inc.
   2. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

4.11 AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows: .
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CADDY; nVent.
      b. Firestone Industrial Products Company.
      c. Mason Industries, Inc.
      d. Vibration Management Corp.
   2. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
   3. Maximum Natural Frequency: 3 Hz.
   4. Operating Pressure Range: 25 to 100 psi (689.48 kPa).
   5. Burst Pressure: At least three times manufacturer's published maximum operating pressure.

6. Minimum deflection as indicated on Drawings.
7. Automatic leveling valve.

4.12 RESTRAINED-AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint: .
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CADDY; nVent.
      b. Firestone Industrial Products Company.
      c. Mason Industries, Inc.
      d. Vibration Management Corp.
   2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
      a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi (3447.38 kPa).
      b. Top plate with elastomeric pad.
      c. Internal leveling bolt that acts as blocking during installation.
   3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
   4. Minimum deflection as indicated on Drawings.
   5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   8. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
   9. Maximum Natural Frequency: 3 Hz.
   10. Operating Pressure Range: 25 to 100 psi (689.48 kPa).
   11. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
   12. Automatic leveling valve.

4.13 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ace Mountings Co., Inc.
      b. CADDY; nVent.
      c. California Dynamics Corporation.
      d. Kinetics Noise Control, Inc.
      e. Mason Industries, Inc.
      f. Novia; A Division of C&P.
      g. Vibration Eliminator Co., Inc.
      h. Vibration Isolation.
      i. Vibration Management Corp.
      j. Vibration Mountings & Controls, Inc.
   2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
   3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.
   4. Minimum deflection as indicated on Drawings.

4.14 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ace Mountings Co., Inc.
      b. CADDY; nVent.
      c. California Dynamics Corporation.
      d. Kinetics Noise Control, Inc.
      e. Mason Industries, Inc.
      f. Novia; A Division of C&P.
      g. Vibration Eliminator Co., Inc.
      h. Vibration Isolation.
      i. Vibration Management Corp.
      j. Vibration Mountings & Controls, Inc.
   2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Minimum deflection as indicated on Drawings.
   7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   8. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   9. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
   10. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

4.15 SNUBBERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. CADDY; nVent.
   2. Kinetics Noise Control, Inc.
   3. Mason Industries, Inc.
   4. Vibration Management Corp.
   5. Vibration Mountings & Controls, Inc.

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
   1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-11 Appendix D for 2012 IBC.
   2. Preset Concrete Inserts: Prequalified in accordance with ICC-ES AC446 testing.
   3. Anchors in Masonry: Design in accordance with TMS 402.
   4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
   5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch (6.35 mm) thick.

4.16 RESTRAINTS - RIGID TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. B-line; Eaton, Electrical Sector.
   2. CADDY; nVent.
   3. California Dynamics Corporation.
   4. Hilti, Inc.
   5. Isolation Technology, Inc.
   6. TOLCO.
   7. Unistrut; Atkore International.
   8. Vibration Mountings & Controls, Inc.

B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

4.17 RESTRAINTS - CABLE TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. B-line; Eaton, Electrical Sector.
   2. CADDY; nVent.
   3. Loos & Co.
   4. Vibration Mountings & Controls, Inc.

B. Restraint Cables: ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.

C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19-10. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

4.18 RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. B-line; Eaton, Electrical Sector.
   2. CADDY; nVent.
   3. Hilti, Inc.
   4. Loos & Co.
   5. Mason Industries, Inc.
   6. TOLCO.
   7. Unistrut; Atkore International.

B. Hanger-Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

4.19 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. B-line; Eaton, Electrical Sector.
      b. Hilti, Inc.
      c. Mason Industries, Inc.
      d. Powers Fasteners.
      e. Simpson Strong-Tie Co., Inc.
      f. Unistrut; Atkore International.
   2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. B-line; Eaton, Electrical Sector.
      b. Hilti, Inc.
      c. Mason Industries, Inc.
      d. Powers Fasteners.
      e. Simpson Strong-Tie Co., Inc.
      f. Unistrut; Atkore International.
   2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-10, Ch. 13.
   1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
   2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.
   1. Undercut expansion anchors are permitted.

4.20 CONCRETE INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. B-line; Eaton, Electrical Sector.
   2. Hilti, Inc.
   3. Mason Industries, Inc.
   4. Powers Fasteners.
   5. Simpson Strong-Tie Co., Inc.
   6. Unistrut; Atkore International.

B. Provide preset concrete inserts that are prequalified in accordance with ICC-ES AC466 testing.

C. Comply with ANSI/MSS SP-58.

4.21 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. CADDY; nVent.
   2. California Dynamics Corporation.
   3. Kinetics Noise Control, Inc.
   4. Mason Industries, Inc.
   5. Novia; A Division of C&P.
   6. Vibration Eliminator Co., Inc.
   7. Vibration Isolation.
   8. Vibration Management Corp.
   9. Vibration Mountings & Controls, Inc.

B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
      a. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
      a. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
      a. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
   4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

4.22 RESTRAINED ISOLATION ROOF-CURB RAILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. CADDY; nVent.
   2. California Dynamics Corporation.
   3. Kinetics Noise Control, Inc.
   4. Novia; A Division of C&P.

5. Thybar Corporation.
6. Vibration Eliminator Co., Inc.
7. Vibration Management Corp.
8. Vibration Mountings & Controls, Inc.

B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.

C. Upper Frame: Shall provide continuous and captive support for equipment.

D. Lower Support Assembly: Shall be formed sheet metal section containing adjustable and removable steel springs that support upper frame. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials and shall be insulated with a minimum of 2 inches (50.8 mm) of rigid glass-fiber insulation on inside of assembly.
   1. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with integrity of roof.
   2. Minimum deflection as indicated on Drawings.

E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

PART 3 EXECUTION

5.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and wind-load control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

5.02 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to wind-load forces.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static and wind force loads within specified loading limits.

5.03 INSTALLATION OF VIBRATION AND WIND-LOAD CONTROL DEVICES

A. Provide vibration and wind-load control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Installation of vibration isolators and wind-load restraints must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

D. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

E. Equipment Restraints:
   1. Install snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.18 mm).
   3. Install wind-load-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

F. Piping Restraints:
   1. Comply with requirements in MSS SP-127.
   2. Space lateral supports a maximum of 40 feet (1219.2 cm) o.c., and longitudinal supports a maximum of 80 feet (2438.4 cm) o.c.
   3. Brace a change of direction longer than 12 feet (365.76 cm).

G. Install wind-load-restraint cables so they do not bend across edges of adjacent equipment or building structure.

H. Install wind-load-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

I. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

J. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

K. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

L. Post-Installed Concrete Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   5. Set anchors to manufacturer's recommended torque, using a torque wrench.
   6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

5.04 ACCOMMODATION OF DIFFERENTIAL MOTION

A. Provide flexible connections in piping systems where they cross structural joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for piping flexible connections.

5.05 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate dimensions of equipment bases with requirements of isolated equipment specified in this and other Sections. Where dimensions of base are indicated on Drawings, they may require adjustment to accommodate isolated equipment.

5.06 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

5.07 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections:
   1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
   3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
   4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
   5. Test to 90 percent of rated proof load of device.
   6. Measure isolator restraint clearance.
   7. Measure isolator deflection.
   8. Verify snubber minimum clearances.
   9. Test and adjust restrained-air-spring isolator controls and safeties.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Furnish and install materials for identification of mechanical products installed under Division 22 and 23.

B. Identification painting of piping.

1.02 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2027.

1.03 REFERENCES

A. ANSA A 13.1 – Scheme for the Identification of Piping Systems.

B. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.

1.04 SUBMITTALS

A. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer’s name and model number.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. W.H. Brady Company

B. Marken Corporation

C. Seton Name Plate Company

2.02 MATERIALS

A. Color (SW = Sherwin Williams Color Reference Number)
   1. Chilled Water Supply: Dark Blue (SW-4056)
   2. Chilled Water Return: Light Blue (SW-4054)
   3. Hot Water Supply: Dark Red (SW-6871)
   4. Hot Water Return: Light Red (SW-6858)
   5. Condenser Water Supply: Light Green (SW-4069)
   6. Condenser Water Return: Dark Green (SW-4071)
   7. Natural Gas: Safety Yellow (SW-4084)

B. Plastic Nameplates: Laminated three-layer plastic with engraved white letters on a black background; minimum size 3 inches (76.2 mm) long and 1 inch (25.4 mm) high. Minimum lettering height for numbers and names is 1/4-inch and other data is 1/8-inch.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering, minimum information indicating flow direction arrow and fluid being conveyed.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

E. Paint:
   1. Material Capability: Provide primers, undercoat, finish coat, and related materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by the manufacturer based on testing and field experience.
   2. Material Quality:
      a. Provide the manufacturer’s highest-quality trade sale paint material of the various coating types specified. Paint material containers not displaying manufacturer’s product identification will not be acceptable.

b. Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish the manufacturer's material data and certificates of performance for proposed situations.
c. Provide primer and undercoat materials with a minimum six month guaranteed life against fade and/or color bleed-through.

3. Colors: Provide color samples to the Architect/Engineer for selection form the manufacturer's full range of standard colors.
4. Primers: Provide the manufacturer's recommended factory-formulated primers that are compatible with the substrate and finish coats indicated. Subject to compliance with requirements, prime coat materials that may be incorporated in the Work include, but are not limited to the following:
   a. Galvanized Metal Primers:
      1) Devoe: 13201 Mirrorlac Galvanized Metal Primer.
      2) Glidden: 5229 Glid-Guard All-Purpose Metal Primer.
      3) Moore: IornClad Galvanized Metal Latex Pirmer #155.
   b. Ferrous Metal Primers
      1) Devoe: 14920 Bar-Ox Quick Dry Metal Primer, Red.
      2) Glidden: 5210 Glid-Guard Universal Fast-Dry Metal Primer.
      3) Moore: IornClad Retardo Rust-Inhibitive Paint #163.
5. Undercoat Materials: Provide the manufacturer's recommended factory-formulated primers that are compatible with the substrate and finish coats indicated. Subject to compliance with requirements, prime coat materials that may be incorporated in the Work include, but are not limited to the following:
   a. Galvanized Metal Primers:
      1) Devoe: 8801 Velour Alkyd Enamel Undercoat.
      2) Glidden: 4200 Spred Ultra Semi-Gloss Enamel.
      3) Moore: Moore's Alkyd Enamel Underbody #217.
   b. Ferrous Metal Primers
      1) Devoe: 8801 Velour Alkyd Enamel Undercoat.
      2) Glidden: 4200 Spred Ultra Semi-Gloss Enamel.
      3) Moore: Moore's Alkyd Enamel Underbody #217.
6. Finish Paint: Provide the manufacturer's recommended factory-formulated primers that are compatible with the substrate and finish coats indicated. Subject to compliance with requirements, prime coat materials that may be incorporated in the Work include, but are not limited to the following:
   a. Galvanized Metal Primers:
      1) Devoe: 26XX Velour Alkyd Semi-Gloss Enamel.
      2) Glidden: 4200 Spred Ultra Semi-Gloss Enamel.
      3) Moore: Moore's Sating Impervo Enamel #235.
   b. Ferrous Metal Primers
      1) Devoe: 26XX Velour Alkyd Semi-Gloss Enamel.
      2) Glidden: 4200 Spred Ultra Semi-Gloss Enamel.
      3) Moore: Moore's Sating Impervo Enamel #235.
   c. Cotton or Canvas Covering Over Insulation Interior Flat Latex Emulsion Size:
      1) Devoe: 36XX Wonder-Tones Latex Flat Wall Paint.
      2) Glidden: 3400 Spred Satin Latex Wall Paint.
      3) Moore: Regal Wall Sating #215.

PART 3 EXECUTION

3.01 PREPARATION

A. Thoroughly clean all surfaces to be painted as required to remove all oil, grease, loose scale, rust, and foreign matter. Piping must be completely dry at the time of application. The painting of piping associated with an operating system is strictly prohibited. Site touch-up of the factory applied coating or paint, to include preparation and painting of field welds, must be completed and approved by the Engineer prior to installation of insulation (No Exceptions).

3.02 INSTALLATION

A. Plastic Nameplates: Secure nameplates to equipment fronts using corrosive resistant screws and rivets. Install nameplates parallel to equipment lines.

B. Plastic Pipe Markers: Install in accordance with manufacturer’s instructions.

C. Plastic Tape Pipe Markers: Install completely around pipe in accordance with manufacturer’s instructions.

D. Equipment
   1. Identify mechanical equipment scheduled on Drawings with nameplates, except of air devices, sprinkler heads, plumbing fixtures, and plumbing shock absorbers.
   2. Identify name, number, function, capacity, and other pertinent information of air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates.

E. Controls: Identify control panels and major control components outside panels with plastic nameplates.

F. Piping
   1. Prepare, undercoat, and finish paint exposed piping, including insulated piping, in mechanical and equipment rooms with colors to meet ANSI standards. In addition, identify all piping , concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Identify service, flow direction and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 10 feet (304.8 cm) on straight runs, including risers and drops, adjacent to each valve and tee at each obstruction. Provide a flow arrow at each identification marker.
   2. Do not paint metallic piping system jackets.

G. Ductwork:
   1. Label ductwork by system type.
   2. Fire Dampers: Label with plastic nameplates in accordance with NFPA 90A.

H. Attach identification for items such as special switches, etc., located in finished areas, on or in the immediate vicinity of the item.

3.03 COLOR CODE FOR PLASTIC PIPE MARKERS AND MARKING TAPES

MATERIAL	BAND	LETTERS AND ARROWS	LEGEND
Cold water (portable) WATER	Green	White	PORTABLE
Fire protection water (WATER)	Red	White	FIRE PR.
Hot water (domestic)	Green	White	H.W.
Hot water re-circulating (domestic)	Green	White	H.W.R.
Heating water supply	Yellow	Black	L.TW.S.
Heating water return	Yellow	Black	L.T.W.R.

Chilled water supply	Green	White	C.H.W.S.
Chilled water return	Green	White	C.H.W.R.
Treated water	Yellow	Black	TR. WATER
Chemical feed	Yellow	Black	CH. FEED
Compressed air	Yellow	Black	COMP. AIR
Natural gas	Blue	White	NAT. GAS
Vacuum	Blue	White	VAC
Fuel oil	Yellow	Black	FUEL OIL

3.04 C MARKER SIZES

OUTSIDE DIAMETER OF PIPE COVERING (INCHES)	LENGTH OF COLOR BAND (INCHES)	ARROW LENGTH BY WIDTH (INCHES)	SIZE OF LEGEND LETTERS AND NUMBERS (INCHES)
Less than 1-1/2	8	8 x 2-1/4	1/2
1-1/ to 1-3/8	8	8 x 2-1/4	3/4
2-1/2 to 1-7/8	12	8 x 2-1/4	1-1/4
8 to 10	24	12 x 4-1/2	2-1/2
Over 10	32	12 x 4-1/2	3-1/2

END OF SECTION

SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

3.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

3.02 SUMMARY

A. Section Includes:
   1. Testing, Adjusting, and Balancing of Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.
   2. Testing, Adjusting, and Balancing of Hydronic Piping Systems:
      a. Constant-flow hydronic systems.
      b. Variable-flow hydronic systems.
   3. Testing, adjusting, and balancing of equipment.
   4. Sound tests.
   5. Vibration tests.
   6. Duct leakage tests verification.
   7. Pipe leakage tests verification.
   8. HVAC-control system verification.

3.03 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

3.04 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
   1. Minimum Agenda Items:
      a. The Contract Documents examination report.
      b. The TAB plan.
      c. Needs for coordination and cooperation of trades and subcontractors.
      d. Proposed procedures for documentation and communication flow.

3.05 ACTION SUBMITTALS

A. Sustainable Design Submittals:
   1. INFORMATIONAL SUBMITTALS

B. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

C. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

D. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

E. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

F. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

G. Certified TAB reports.

H. Sample report forms.

I. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

3.06 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
   2. TAB Technician: Employee of the TAB specialist and certified by AABC.

B. TAB Specialists Qualifications, Certified by NEBB or TABB:
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
   2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

E. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

3.07 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

5.01 TAB SPECIALISTS

A. Subject to compliance with requirements, engage a qualified TAB agency to perform services defined herein.

5.02 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify

that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.

F. Examine equipment performance data, including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine operating safety interlocks and controls on HVAC equipment.

L. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default points if different from indicated values.

5.03 PREPARATION

A. Prepare a TAB plan that includes the following:
   1. Equipment and systems to be tested.
   2. Strategies and step-by-step procedures for balancing the systems.
   3. Instrumentation to be used.
   4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
   1. Airside:
      a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
      b. Duct systems are complete with terminals installed.
      c. Volume, smoke, and fire dampers are open and functional.
      d. Clean filters are installed.
      e. Fans are operating, free of vibration, and rotating in correct direction.
      f. Variable-frequency controllers' startup is complete and safeties are verified.
      g. Automatic temperature-control systems are operational.
      h. Ceilings are installed.

i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

5.04 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance, ASHRAE 111 and in this Section.

B. Cut insulation, ducts, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
   3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation.

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

5.05 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
   1. Motors.
   2. Fans and ventilators.
   3. Terminal units.
   4. Radiant heaters.
   5. Unit heaters.
   6. Condensing units.
   7. Condensers.
   8. Air-handling units.
   9. Rooftop air-conditioning units.
   10. Split-system air conditioners.
   11. Fan coil units.

5.06 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' Record drawings duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

5.07 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
      a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
      b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
      c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
   2. Measure fan static pressures as follows:
      a. Measure static pressure directly at the fan outlet or through the flexible connection.
      b. Measure static pressure directly at the fan inlet or through the flexible connection.
      c. Measure static pressure across each component that makes up the air-handling system.
      d. Report artificial loading of filters at the time static pressures are measured.
   3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
   4. Obtain approval from EOR and Commissioning Authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
   5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
   1. Measure airflow of submain and branch ducts.
   2. Adjust submain and branch duct volume dampers for specified airflow.
   3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.
   1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
   2. Measure inlets and outlets airflow.
   3. Adjust each inlet and outlet for specified airflow.
   4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.
   1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
   2. Re-measure and confirm that total airflow is within design.
   3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
   4. Mark all final settings.
   5. Test system in economizer mode. Verify proper operation and adjust if necessary.
   6. Measure and record all operating data.
   7. Record final fan-performance data.

5.08 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:
   1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
   2. Verify that the system is under static pressure control.
   3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
   4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
      a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
      b. Measure airflow and adjust calibration factors as required for design maximum airflow. Record calibration factor.
      c. When the maximum airflow is correct, balance the air outlets downstream from terminal units.
      d. Adjust controls so that terminal is calling for minimum airflow.
      e. Measure airflow and adjust calibration factors as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
      f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
   5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturers.
      a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
      b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
      c. Where duct conditions are allowed, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
      d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
   6. Measure fan static pressures as follows:
      a. Measure static pressure directly at the fan outlet or through the flexible connection.
      b. Measure static pressure directly at the fan inlet or through the flexible connection.
      c. Measure static pressure across each component that makes up the air-handling system.
      d. Report any artificial loading of filters at the time static pressures are measured.
   7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
      a. Balance the return-air ducts and inlets.
      b. Verify that terminal units are meeting design airflow under system maximum flow.
   8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set points and give to controls Contractor.
   9. Verify final system conditions as follows:

a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
b. Re-measure and confirm that total airflow is within design.
c. Re-measure final fan operating data, speed, volts, amps, and static profile.
d. Mark final settings.
e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
f. Verify tracking between supply and return fans.

5.09 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

5.10 PROCEDURES FOR AIR-COOLED CONDENSING UNITS

A. Verify proper rotation of fan(s).

B. Measure and record entering- and leaving-air temperatures.

C. Measure and record entering and leaving refrigerant pressures.

D. Measure and record operating data of compressor(s), fan(s), and motors.

5.11 PROCEDURES FOR AIR-COOLED CONDENSERS

A. Verify proper rotation of fan(s).

B. Measure and record entering- and leaving-air temperatures.

C. Measure and record entering and leaving refrigerant pressures.

D. Measure and record operating data of fan(s) and motor(s).

E. Kitchen Hoods:
1. Type 1: Measure and record pressure drop and face velocity of hood filters and slots in accordance with hood manufacturer's instructions. Consult hood manufacturer to determine hood airflow using recorded information.
2. Type 2: Measure and record airflow by duct traverse.
3. Capture and Containment: Check each hood for proper capture and containment using a smoke-emitting device. Observe and report performance. Make adjustments to achieve optimum results.

F. AHJ Tests: Conduct additional tests required by authorities having jurisdiction.

5.12 SOUND TESTS

A. After systems are balanced and Substantial Completion, measure and record sound levels at ten locations as designated by the Architect.

B. Instrumentation:
1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.

2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (Leq).
3. The sound-testing meter must be capable of using one-third octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
4. The accuracy of the sound-testing meter shall be plus or minus one decibel.

C. Test Procedures:
1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
2. Equipment should be operating at design values.
3. Calibrate the sound-testing meter prior to taking measurements.
4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
5. Record a set of background measurements in dBA and sound pressure levels in the eight unweighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.
6. Take sound readings in dBA and sound pressure levels in the eight unweighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.
7. Take readings no closer than 36 inches from a wall or from the operating equipment and approximately 60 inches from the floor, with the meter held or mounted on a tripod.
8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:
1. Report shall record the following:
a. Location.
b. System tested.
c. dBA reading.
d. Sound pressure level in each octave band with equipment on and off.
2. Plot sound pressure levels on Noise Criteria (NC) worksheet with equipment on and off.

5.13 VIBRATION TESTS

A. After systems are balanced and Substantially Completion, measure and record vibration levels on equipment having motor horsepower equal to or greater than 10.

B. Instrumentation:
1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
4. Verify calibration date is current for vibration meter before taking readings.

C. Test Procedures:
1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.
3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
4. Record CPM or rpm.

5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.

D. Reporting:
1. Report shall record location and the system tested.
2. Include horizontal-vertical-axial measurements for tests.
3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from AABC's "National Standards for Total System Balance." Acceptable levels of vibration are normally "smooth" to "good."
4. Include in General Machinery Vibration Severity Chart, with conditions plotted.

5.14 HVAC CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:
1. Verify HVAC control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

5.15 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
2. Air Outlets and Inlets: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

5.16 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

5.17 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans performance forms, including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Heating coil, dry-bulb conditions.
    e. Face and bypass damper settings at coils.
    f. Fan drive settings, including settings and percentage of maximum pitch diameter.
    g. Variable-frequency controller settings for variable-air-volume systems.
    h. Settings for pressure controller(s).
    i. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Terminal units.
5. Balancing stations.
6. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units, include the following:
1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Make and type.

d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and speed.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan speed.
   d. Inlet and discharge static pressure in inches wg.
   e. For each filter bank, filter static-pressure differential in inches wg.
   f. Preheat-coil static-pressure differential in inches wg.
   g. Cooling-coil static-pressure differential in inches wg.
   h. Heating-coil static-pressure differential in inches wg.
   i. List for each internal component with pressure-drop, static-pressure differential in inches wg.
   j. Outdoor airflow in cfm.
   k. Return airflow in cfm.
   l. Outdoor-air damper position.
   m. Return-air damper position.
   n. Vortex damper position.

F. Apparatus-Coil Test Reports:
1. Coil Data:
   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch o.c.
   f. Make and model number.
   g. Face area in sq. ft..
   h. Tube size in NPS.
   i. Tube and fin materials.
   j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches wg.
   d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
   e. Return-air, wet- and dry-bulb temperatures in deg F.
   f. Entering-air, wet- and dry-bulb temperatures in deg F.
   g. Leaving-air, wet- and dry-bulb temperatures in deg F.

h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
1. Unit Data:
a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm.
i. Face area in sq. ft..
j. Minimum face velocity in fpm.
2. Test Data (Indicated and Actual Values):
a. Heat output in Btu/h.
b. Airflow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Motor Data:
a. Motor make, and frame type and size.
b. Horsepower and speed.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.
g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan speed.

d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
   1. Report Data:
      a. System fan and air-handling-unit number.
      b. Location and zone.
      c. Traverse air temperature in deg F.
      d. Duct static pressure in inches wg.
      e. Duct size in inches.
      f. Duct area in sq. ft..
      g. Indicated airflow rate in cfm.
      h. Indicated velocity in fpm.
      i. Actual airflow rate in cfm.
      j. Actual average velocity in fpm.
      k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:
   1. Unit Data:
      a. System and air-handling unit identification.
      b. Location and zone.
      c. Apparatus used for test.
      d. Area served.
      e. Make.
      f. Number from system diagram.
      g. Type and model number.
      h. Size.
      i. Effective area in sq. ft..
   2. Test Data (Indicated and Actual Values):
      a. Airflow rate in cfm.
      b. Air velocity in fpm.
      c. Preliminary airflow rate as needed in cfm.
      d. Preliminary velocity as needed in fpm.
      e. Final airflow rate in cfm.
      f. Final velocity in fpm.
      g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils of terminal units, include the following:
   1. Unit Data:
      a. System and air-handling-unit identification.
      b. Location and zone.
      c. Room or riser served.
      d. Coil make and size.
   2. Test Data (Indicated and Actual Values):
      a. Air flow rate in cfm.
      b. Entering-air temperature in deg F.
      c. Leaving-air temperature in deg F.

L. Instrument Calibration Reports:
   1. Report Data:
      a. Instrument type and make.
      b. Serial number.
      c. Application.

d. Dates of use.
e. Dates of calibration.

5.18 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of the Commissioning Authority.

B. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
   1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to the previous report.
   2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.

F. Prepare test and inspection reports.

5.19 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 230713
HVAC INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Furnish and install thermal insulation for mechanical and plumbing piping systems including jackets and accessories.

B. HVAC system includes horizontal roof drain lines, and waste lines which receive condensate from air handling units or evaporators.

1.02 REFERENCE STANDARDS

A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019, with Editorial Revision (2023).

B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2024).

C. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2017 (Reapproved 2023).

D. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2025.

E. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.

F. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2022.

G. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2025.

H. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation; 2024.

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

1.03 RELATED SECTIONS

A. Section 090190 – Maintenance of Painting and Coatings.

B. Section 210529 – Hangers and Supports for HVAC Piping and Equipment.

C. Section 210553 – Identification for HVAC Piping and Equipment.

1.04 REFERENCES

A. ASTM C 178 – Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-HOT-Plate Apparatus.

B. ASTM C195 – Mineral Fiber Thermal Insulation Cement.

C. ASTM C533 – Calcium Silicate Block and Pipe Thermal Insulation.

D. ASTM C 534 - Preformed Flexible Elastomeric Cellular Thermal Insulation.

E. ASTM C547 – Mineral Fiber Preformed Pipe Insulation.

F. ASTM C591 – Preformed Cellular Polyurethane Thermal Insulation.

G. ASTM C1126 – Rigid Cellular Phenolic Thermal Insulation.

H. ASTM B 209 – Aluminum and Aluminum-alloy Sheet and Plate.

I. ASTM E84 – Surface Burning Characteristics of Building Materials.

J. ASTM E 96 –Water Vapor Transmission of Materials.

1.05 SUBMITTALS

A. Include product description, list of materials, and thickness for each service and locations.

B. Include detailed drawings of insulation dams.

1.06 QUALITY ASSURANCE

A. Application Company Qualifications: The installation company must be solely and exclusively in the business of installation for the previous consecutive fiver year period. The installation company must also be regularly engaged in installing the specific specified insulation material types on projects of equal or greater magnitude and scope as this project for the previous consecutive five-year period. Documentation of the above listed requirements must be submitted prior to insulation material submitted.

B. Application Personnel Qualifications: The installing company must provide qualified installation personnel on this project jobsite directly employed by them who are skilled and proficient at installing the specific specified insulation Material types.

C. Any material found, by the A/E, to be improperly installed or not installed in total compliance with the specific installation instructions and methods (written or implied) of the material manufacturer must be removed by the installing company. The preparation instructions must be followed prior to the re-installation of the insulation material using the correct installation instructions and methods of the material manufacturer.

D. All material (to include, but not limited to, insulation, jackets, facings, coatings, mastics, adhesive, sealants, etc.) Installed inside the building must have a certified and tested composite flame spread/smoke developed rating of 25/50 inch (12.7 mm) accordance with ASTM E84.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Insulation
   1. Ownes-Corning Fiberglass Corporation.
   2. UpJohn CRP/DOW Chemical Company.
   3. Knuff Corporation.
   4. FGH Fabricators, Inc.
   5. Armstrong.
   6. K-Flex USA

B. Jackets
   1. Childers Products Company.
   2. PABCO.
   3. RFR Products, Inc.

2.02 INSULATION MATERIALS

A. Type “B” Insulation: Elastomer, closed cell, flexible, insulation; ASTM E 96, maximum vapor transmission rating of 0.20 pers; ASTM C177; ‘k’ value of 0.27 at 75 degrees Fahrenheit (23.89 degrees Celsius).

B. Type “C” Insulation: Flexible Fiberglass Duct Insulation (Indoor application): ASTM C553, Type I, Class B-4, 2 " thick, 1.5 PCF density, minimum R-6 for indoor conditioned applications and R-8 for indoor unconditioned applications, Provide with FSK foil faced continuous vapor barrier.

C. Type “D” Insulation: Rigid Fiberglass Duct Insulation: ASTM C612, Class 1, 2" thick, 3.0 PCF density, for both supply and exhaust round ducts exposed to view locations, or spaces without ceilings.

2.03 INSULATION JACKETS

A. ASTM C 921, Type I for temperatures below ambient; Type II for temperatures above ambient.

B. ASJ: All Service Jacket fabricated from 45 lb. bleached white kraft paper outer layer reinforced with fiberglass yarn scrim and 8 micron aluminum foil inner layer laminated together with a flame retardant adhesive. Comply with ASTM 1136.

C. Metal Jackets: 0.020” thick aluminum jacket with Polyethylene film moisture barrier and "Z" closures for weather-proof construction.

D. Pipe Jackets
   1. Indoor Concealed Applications: None Required
   2. Indoor Exposed Applications: Factory applied ASJ All Service Jacket.
   3. Outdoor Applications: Metal Jacketing

2.04 ACCESORIES

A. Insulation Bands: 3/4-inch-wide; 0.015-inch-thick galvanized steel, stainless steel or 0.007-inch-thick aluminum.

B. Metal Jacket Bands: 3/8-inch-wide; 0.015-inch-thick aluminum.

C. Mechanical Fasteners:
   1. Gemco Type IH-A from Goodloe E. Moore, Inc., Danville, IL 800-331-1164.
   2. Eckoustic-Klip from Eckel Industries Inc., Cambridge, MA 617-491-3221.
   3. INC Stickpin from Industrial Noise Control Inc. Addison, IL 312-620-1998.

D. Duct Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturers for applications indicated.
   1. 15-141 from King Co., St. Louis, MO 314-772-9953.
   2. Tuffbond from Goodloe E. Moore, Inc., Danville, IL 800-331-1164.
   3. INC C-700 from Industrial Noise Control Inc., Addison, IL 312-620-1998.Insulating Cement: ASTM C195; hydraulic setting mineral wool; Ryder One-Coat or similar.

E. Sealants: Used at valve, fittings and where insulation is terminated. Brush applied sealant to end of insulation and continued along pipe surface. Provide Childers CP-30 L.O. sealant.

F. Adhesives: Used to adhere to the longitudinal lap seam of vapor barrier jackets and at butt joints between insulation or fitting covers. Provide Childers CP-82 or approved equal as general purpose adhesive. Use Childers CP-97 fibrous adhesive for calcium silicate or when adhering pipe saddles and shields to the insulation.

G. Primers: Provide Childers CP-50 diluted 50% with water primer to cover insulation cements prior to finish coating.

H. Finish: Provide Childers CP-30 L.O. as a general-purpose finish to coat the longitudinal seams and butt joints of vapor barrier jackets or glass cloth jackets. Use Childers CP-50 reinforced with glass cloth as an adhesive and seizing for canvas and in other locations as indicated.

PART 3 EXECUTION

3.01 DUCT SYSTEM INSULATION

A. Cold Ducts: Temperatures below the space dew point shall have the insulation vapor barrier be continuous and unbroken through inside walls, sleeves and floor openings. Where connection is made to fire or fire/smoke damper in wall or floor the vapor barrier must extend to the wall or floor to prevent ambient air water vapor from condensing on the cold surfaces of the fire damper.

B. Duct Wrap: Fasten all longitudinal and circumferential laps with outward clinching staples 3" on center. On rectangular ducts over 24" wide, apply as above and hold insulation in place on bottom side with mechanical pins and clips on 12" centers.

C. Duct Wrap: Seal all joints, fastener penetrations and other breaks in vapor barrier with 3-inch-wide strips of the same facing materials with factory applied vapor barrier adhesive, or 3 inch (76.2 mm) wide strips of white glass fabric embedded between two coats of vapor barrier mastic, Childers CP-30 or approved equal.

D. Cold Duct (Below Ambient Temperature):

E. Application Requirements: Insulate the following cold duct:
   1. Outdoor air intake duct between air entrance and fan inlet or HVAC unit inlet.
   2. HVAC supply duct between fan discharge, or HVAC unit discharge, and room terminal outlet.
      a. Insulate neck, backside, and bells of supply diffusers.
   3. HVAC plenums and unit housings not pre-insulated at factory or lined.
   4. Exhaust duct work within the building at non air-conditioned spaces.

F. Exhaust ductwork within the air-conditioned spaces do not require insulation. Exhaust duct on roof exposed to the outside weather do not require insulation.

3.02 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Insulated ductwork conveying air below ambient temperature:
   1. Provide insulation with vapor barrier jackets.
   2. Finish with tape and vapor barrier jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate the entire system including fittings, joints, flanges, dampers, flexible connections, and expansion joints.

C. External Duct Insulation Application:
   1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive to match jacket.
   2. Secure insulation without vapor barrier with staples, tape, or wires.
   3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
   4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
   5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

D. Duct and Plenum Liner Application:
   1. Adhere insulation with adhesive for 100 percent coverage.
   2. Secure insulation with mechanical liner fasteners. Refer to SMACNA Standards for spacing.
   3. Seal and smooth joints.
   4. Seal liner surface penetrations with adhesive.
   5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

E. All equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these specifications.

F. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such an occupation. All insulation shall be applied in strict accordance with these specifications and with factory-printed recommendations on items not herein mentioned.

Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.

G. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet nfpa for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with contractor's submittal data for this section of the specifications. No material may be used that, when tested by the astm e84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

H. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3"). Where the insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable.

I. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

J. For purpose of definition in this specification: "concealed" areas are those areas which cannot be seen by the building occupants, and "exposed" areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

K. The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturer’s recommendations.

3.03 SCHEDULE

APPLICATION	TYPE	PIPE SIZE	INSULATION THICKNESS
CONDENSATE DRAIN LINES (INTERIOR)	B	ALL SIZES	3/4”
REFRIGERANT SUCTION PIPING	B	ALL SIZES	1”
INDOOR DUCTWORK INSULATION CONCEALED SPACES	C	ALL SIZES	2” & 1.5 LBS DENSITY
INDOOR DUCTWORK INSULATION NON-CONCEALED SPACES PROVIDE DOUBLE WALL DUCTWORK OR ALUMINUM JACKET	D	ALL SIZES	2” & 3.0 LBS DENSITY

END OF SECTION

SECTION 230800
COMMISSIONING OF HVAC

SECTION 23 08 00

COMMISSIONING OF HVAC

PART 1 GENERAL

3.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

3.02 SUMMARY

A. Section includes commissioning process requirements for HVAC systems, assemblies, and equipment.

B. Related Sections:
   1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

3.03 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Owner’s designated 3rd party Commissioning Authority.

C. HVAC: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

3.04 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

3.05 CXA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

3.06 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:
   1. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.

2. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC systems, assemblies, equipment, and components to be verified and tested.
3. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
4. Certificate of readiness certifying that HVAC systems, subsystems, equipment, and associated controls are ready for testing.
5. Test and inspection reports and certificates.
6. Corrective action documents.
7. Verification of testing, adjusting, and balancing reports.

B. Plan for delivery and review of submittals, systems manuals, and other documents and reports.

3.07 SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

5.01 TESTING PREPARATION

A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

5.02 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC systems at the direction of the CxA.

D. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
1. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
2. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting,

and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

3. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

5.03 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC testing shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC Contractor, testing and balancing Contractor, and HVAC Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

5.04 HVAC SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in Division 23 boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.

B. HVAC Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls." Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.

3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of gas, steam and hot-water systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

F. HVAC Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC terminal equipment and unitary equipment.

G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION

SECTION 230923
DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. DDC Building Automation System (BAS) system for monitoring and controlling HVAC, electrical, and plumbing systems.

B. Special Requirements:
   1. Provide all electrical power required for a complete and fully functional system at no additional cost to owner where such power requirements exceed the electrical power circuits indicated on the drawings.
   2. BAS implementations utilizing wireless in lieu of wired network communication architecture must be preapproved by owner in writing prior to bidding. Wireless BAS system implementations will not be acceptable otherwise.

1.03 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. BACnet Specific Definitions:
   1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
   2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
   3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
   4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
   5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.

D. Binary: Two-state signal where a high signal level represents ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

E. Controller: Generic terms for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.

F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

G. COV: Changes in value.

H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

I. Distributed Control: Processing system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote

subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.

J. DOCSIS: Data-Over Cable Service Interface Specifications.

K. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

L. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.

M. LAN: Local area network.

N. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

O. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.

P. Modbus TCP/IP: An open protocol for exchange of process data.

Q. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

R. MTBF: Mean time between failures.

S. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

T. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to the protocol.

U. Peer to Peer: Networking architecture that treats all network stations as equal partners.

V. RAM: Random access memory.

W. RF: Radio frequency.

X. Router: Device connecting two or more networks at network layer.

Y. Server: Computer used to maintain system configuration, historical and programming database.

Z. TCP/IP: Transport control protocol/Internet protocol.

AA. UPS: Uninterruptible power supply.

BB. USB: Universal Serial Bus.

CC. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

DD. VAV: Variable air volume.

1.04 REFERENCE STANDARDS

A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.05 PREINSTALLATION MEETINGS

A. Submittal Review and Preinstallation Conference: Schedule conference with Engineer’s Office.

1.06 SUBMITTALS

A. Product Data: For each type of product include the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation and maintenance instructions including factors affecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

B. Software Submittal:
   1. Description and technical data of all software provided, and cross-referenced to products in which software will be installed.
   2. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
   3. Description of operator interface to alphanumeric and graphic programming.
   4. Description of system database, including all data included in database, database capacity and limitations to expand database.
   5. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden and system throughout.

C. Shop Drawings:
   1. General Requirements:
      a. Include cover drawing with Project name, location, Owner, Architect, Contractor and issue date with each Shop Drawings submission.
      b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
      c. Drawings Size: 11”x17”.
   2. Plan Drawings indicating the following:
      a. Screened backgrounds of walls, structural grid lines, HVAC temperature control zones and equipment. Include room names and numbers with coordinated placement.
      b. Each desktop workstation, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
      c. Information, drawn to scale
      d. Proposed routing of wiring, cabling, conduit and tubing, coordinated with building services for review before installation.
   3. Schematic drawings for each controlled HVAC system indicating the following:
      a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
      b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.

c. A graphic showing location of control I/O in proper relationship to HVAC system.
d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays, and interface to DDC controllers.
g. Narrative sequence of operation.
h. Graphic sequence of operation, showing all inputs and output logical blocks.

4. Control panel drawings indicating the following:
   a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
   b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates, and allocated spare space.
   c. Front, rear, and side elevations and nameplate legend.
   d. Unique drawing for each panel.
5. DDC system network riser diagram indicating the following:
   a. Each device connected to a network with unique identification for each.
   b. Interconnection of each different network in DDC system.
   c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
   d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.
6. DDC system electrical power riser diagram indicating the following:
   a. Each point of connection to field power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
   b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
   c. Each product requiring power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
   d. Power wiring type and size, race type, and size for each.
7. Monitoring and control signal diagrams indicating the following:
   a. Control signal cable and wiring between controllers and I/O.
   b. Point-to-point schematic wiring diagrams for each product.
8. Color graphics indicating the following:
   a. Itemized list of color graphic displays to be provided.
   b. For each display screen to be provided, a true color copy showing layout of pictures, graphics, and data displayed.
   c. Intended operator access between related hierarchical display screens.

D. System Description:
1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
2. Complete listing and description of each report, log and trend for format and timing, and events which initiate generation.
3. System and product operation under each potential failure condition including, but not limited to, the following:
   a. Loss of power.
   b. Loss of network communication signal.
   c. Loss of controller signals to inputs and outpoints.

d. Operator workstation failure.
e. Server failure.
f. Gateway failure.
g. Network failure
h. Controller failure.
i. Instrument failure.
j. Control damper and valve actuator failure.

4. Complete bibliography of documentation and media to be delivered to Owner.
5. Description of testing plans and procedures.
6. Description of Owner training.

E. Delegated-Design Submittal: For DDC system products and installation indicated as being delegated.
1. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
2. Schedule and design calculations for control dampers and actuators.
a. Flow at Project design and minimum flow conditions.
b. Face velocity at Project design and minimum airflow conditions.
c. Pressure drop across damper at Project design and minimum airflow conditions.
d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
e. Maximum close-off pressure.
f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
g. Torque required at worst case condition for sizing actuator.
h. Actuator selection indicating torque provided.
i. Actuator signal to control damper (on, close, or modulate).
j. Actuator position on loss of power.
k. Actuator position on loss of control signal.
3. Schedule and design calculations for selecting flow instruments.
a. Instrument flow range.
b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter, and output signal for remote control.
c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter, and output signal for remote control.
d. Pressure-differential loss across instruments at Project design flow conditions.
e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

F. Sample Warranty: For manufacturer's warranty.

G. Operation and Maintenance Data: For DDC system to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
c. As-built versions of submittal Product Data.
d. Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for DDC system and products.

e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to:
   1) Design and install new points, panels, and other hardware.
   2) Perform preventive maintenance and calibration.
   3) Debug hardware problems.
   4) Repair or replace hardware.
h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
j. List of recommended spare parts with part numbers and suppliers.
k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
m. Licenses, guarantees, and warranty documents.
n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
o. Owner training materials.

1.07 QUALITY ASSURANCE

A. DDC System Provider Qualifications:
   1. Authorized representative of, and trained by, DDC system manufacturer.
   2. In-place facility is located within 25 miles (40.23 kilometers) of Project.
   3. Each person assigned to the Project shall have demonstrated past experience.
   4. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
   5. Service and maintenance staff assigned to support Project during warranty period.
   6. DDC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include a Project-specific written letter, signed by manufacturer's corporate officer, if requested.

1.08 WARRANTY

A. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner’s warranty service request.

B. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

C. If the engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, the engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.

D. Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve the contractor-identified

software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.

E. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

1.09 OWNERSHIP OF PROPRIETRY AMTERIAL

A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:

B. Graphics

C. Record drawings

D. Database

E. Application programming code

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Provide factory manufactured direct digital control (DDC) systems incorporating microprocessor-based monitoring and control including analog/digital conversion and program logic

2.02 MANUFACTURERS

A. Provide systems utilizing one of the following owner-approved manufacturers' BAS DDC control system products:
   1. Carrier i-Vu
   2. Trane Tracer / Ensemble

2.03 MATERIALS

A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.04 COMMUNICATION

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.

B. Install new wiring and network devices as required to provide a complete and workable control network.

C. Use existing Ethernet backbone for network segments marked "existing" on project drawings.

D. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

E. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
   1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
   2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all

cross-controller links required to execute control strategies specified in Section 23 09 93. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

F. Workstations, Building Control Panels, and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight saving and standard time as applicable.

G. Systems shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

2.05 OPERATOR INTERFACE

A. Operator Interface. Web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information. The Operator Workstation or server shall conform to the BACnet Operator Workstation (B-OWS) or BACnet Advanced Workstation (B-AWS) device profile as specified in ASHRAE/ANSI 135 BACnet Annex L.

B. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.

C. System Software.
   1. System Graphics. The operator interface software shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.
      a. Functionality. Graphics allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
      b. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
      c. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
      d. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in or shall only require widely available no-cost plug-ins (such as Adobe Flash).
   2. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in the same formats as are used for system graphics.
   3. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.

D. System Applications. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface.

If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.

1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
2. Manual Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
3. System Configuration. The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection. Operators shall be able to configure the system.
4. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
5. Security. Each operator shall be required to log on to the system with username and password in order to view, edit, add, or delete data.
    a. Operator Access. The username and password combination shall define accessible viewing, editing, adding, and deleting privileges for that operator. Users with system administrator rights shall be able to create new users and edit the privileges of all existing users.
    b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. This auto logoff time shall be user adjustable.
    c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
6. System Diagnostics. The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator.
7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Section 23 09 93 (Sequences of Operation). Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
8. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms or mnemonics.
9. Alarm Reactions. Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
10. Alarm and Event log. Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms and archive closed alarms to the workstation or web server hard disk.
11. Trend Logs. The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Section 23 09 93 (Sequences of Operation). Trends shall be BACnet trend objects.

12. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.
13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
14. Standard Reports. Furnish the following standard system reports:
    a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
    b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
    c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
        1) Alarm History.
        2) Trend Data. Operator shall be able to select trends to be logged.
        3) Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.

E. Workstation Application Editors. Each PC or browser workstation shall support editing of all system applications. The applications shall be downloaded and executed at one or more of the controller panels.
    1. Controller. Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
    2. Scheduling. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and schedule type. Exception schedules and holidays shall be shown clearly on the calendar. The start and stop times for each object shall be adjustable from this interface.
    3. Custom Application Programming. Provide the tools to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
        a. Language. Language shall be graphically based or English language oriented. If graphically based, language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks. If English language oriented, language shall be based on thesyntax of BASIC, FORTRAN, C, or PASCAL, and shall allow for free-form programming that is not column-oriented or "fill-in-the-blanks."
        b. A full-screen character editor programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate features such as cut/ paste and find.
        c. The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.
        d. The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and observe any intermediate values and/or results.
        e. The programming language shall support conditional statements (IF/THEN/ELSE/ ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

f. The programming language shall support floating-point arithmetic using the following operators: +, ÷, ×, and square root. The following mathematical functions also shall be provided: absolute value and minimum/maximum value.
g. The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program. Values from all of the above variables shall be readable by the language so that they can be used in a program for such purposes as IF/ THEN comparisons, calculations, etc.
h. The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.
i. The programming language shall have predefined variables representing the status and results of the system software and shall be able to enable, disable, and change the setpoints of the system software described below.

F. Portable Operator's Terminal. Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.

2.06 CONTROLLER SOFTWARE

A. Furnish the following applications for building and energy management. All software application shall reside and operate in the system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.

B. System Security. See Paragraph 2.3.E.5 (Security) and Paragraph 2.3.E.14.c.iii (Operator Activity).

C. Scheduling. Provide the capability to execute control functions according to a user created or edited schedule. Each schedule shall provide the following schedule options as a minimum:
1. Weekly Schedule. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule has executed, the system shall discard and replace the exception schedule with the standard schedule for that day of the week.
3. Holiday Schedules. Provide the capability for the operator to define up to 24 special or holiday schedules. These schedules will be repeated each year. The operator shall be able to define the length of each holiday period.

D. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.

E. Binary Alarms. Each binary object shall have the capability to be configured to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.

F. Analog Alarms. Each analog object shall have both high and low alarm limits. The operator shall be able to enable or disable these alarms.

G. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display on graphics.

H. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.

I. Demand Limiting.

1. The demand-limiting program shall monitor building power consumption from a building power meter (provided by others) which generates pulse signals or a BACnet communications interface. An acceptable alternative is for the system to monitor a watt transducer or current transformer attached to the building feeder lines.
2. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified in Section 23 09 93 (Sequences of Operation). When demand drops below adjustable levels, system shall restore loads as specified.

J. Maintenance Management. The system shall be capable of generating maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in 23 09 93 (Sequences of Operation).

K. Sequencing. Application software shall sequence chillers, boilers, and pumps as specified in Section 23 09 93 (Sequences of Operation).

L. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs. The calculation interval, PID gains, and other tuning parameters shall be adjustable by a user with the correct security level.

M. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.

N. Energy Calculations.
1. The system shall accumulate and convert instantaneous power (kW) or flow rates (L/s gpm to energy usage data.
2. The system shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.

O. Anti-Short Cycling. All binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.

P. On and Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and a setpoint. The algorithm shall be direct-acting or reverse-acting.

Q. Runtime Totalization. Provide software to totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Section 23 09 93 (Sequence of Operations).

2.07 CONTROLLERS

A. General. Provide an adequate number of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified in Section 23 09 23 Article 1.9 (System Performance). Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.

B. BACnet.
1. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L, and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet

Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.

3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
4. Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
5. BACnet Communication.
    a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
    b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
    c. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
    d. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
    e. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
    f. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.

C. Communication
1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator’s Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
4. Stand-Alone Operation. Each piece of equipment specified in Section 23 09 93 shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network such as outdoor air conditions, supply air or water temperature coming from source equipment, etc.

D. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

E. Keypad. Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator’s Terminal for the system.

F. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.

G. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to a field-removable modular terminal strip or to a termination card

connected by a ribbon cable. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

H. Memory.
   1. Controller memory shall support operating system, database, and programming requirements.
   2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
   3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.

I. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1.09 yard (1 meter) (3 ft).

J. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.08 INPUT AND OUTPUT INTERFACE

A. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.

B. Protection. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground shall cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no controller damage.

C. Binary Inputs. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.

D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall also accumulate up to 10 pulses per second.

E. Analog Inputs. Analog inputs shall allow the monitoring of low-voltage (0–10 Vdc), current (4–20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.

F. Binary Outputs. Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on Building Controllers shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.

G. Analog Outputs. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0–10 Vdc or a 4–20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.

I. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

J. System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system

2.09 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
   1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
      (a) Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
      (b) Line voltage units shall be UL recognized and CSA listed.

B. Power Line Filtering.
   1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
      (a) Dielectric strength of 1000 V minimum
      (b) Response time of 10 nanoseconds or less
      (c) Transverse mode noise attenuation of 65 dB or greater
      (d) Common mode noise attenuation of 150 dB or greater at 40–100 Hz

2.10 AUXILIARY CONTROL (FIELD) DEVICES

A. Space Sensors
   1. Provide surface mounted space sensors incorporating the following measurement features:
      a. Dry bulb space temperature
      b. Space relative humidity
      c. Space CO2 concentration
      d. Motion based occupancy detection
   2. Space sensors shall NOT be provided with local display, local adjustment, or over-ride switches unless indicated on drawings or requested by owner.

B. Control Dampers, unless otherwise specified elsewhere, shall be as follows:
   1. Type. Control dampers shall be the parallel or opposed-blade type as specified below or as scheduled on drawings.
      a. Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.
      b. Other modulating dampers shall be opposed-blade type.
      c. Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.
   2. Frame. Damper frames shall be minimum 13 gauge galvanized steel channel or ⅛ inch extruded aluminum with reinforced corner bracing.
   3. Blades. Damper blades shall be airfoil type fabricated from aluminum or stainless steel and shall not exceed 8 inches (203.2 mm) in width or 48 inches length. Blades shall be

suitable for up to 2000 fpm air velocity performance. Blades shall be not less than 16 gauge material thickness.

4. Shaft Bearings. Damper shaft bearings shall be manufacturer's extended-life premium quality as recommended for application, oil impregnated sintered bronze, or better.
5. Seals. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 10 cfm per ft2 damper area at 4 inch (101.6 mm). w.g. differential pressure.
6. Sections. Individual damper sections shall not exceed 48 inch (1219.2 mm). × 60 inch (1524 mm). Each section shall have at least one damper actuator.
7. Provide dampers for modulating service with a linear flow characteristic.
8. Linkages. Dampers shall have exposed linkages.

C. Electric Damper and Valve Actuators.
   1. Damper and Valve Actuators shall be Belimo manufacturer unless preauthorized by engineer.
   2. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
   3. Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).
   4. Signal and Range. Proportional actuators shall accept a 0–10 Vdc or a 0–20 mA control signal and shall have a 2–10 Vdc or 4–20 mA operating range. Floating motor actuators may be substituted for proportional actuators in terminal unit applications only.
   5. Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
   6. Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 60 inch (1524 mm).-lb torque capacity shall have a manual crank.

D. Binary Temperature Devices.
   1. Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 55°F–85°F setpoint range, 2°F maximum differential, and vented ABS plastic cover.
   2. Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 55°F–85°F setpoint range, 2°F maximum differential, and vented ABS plastic cover.
   3. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 20 ft long OR AS REQUIRED TO COVER THE FULL FACE AREA OF THE COIL. Element shall sense temperature along its entire length and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

E. Temperature Sensors.
   1. Type. Industry standard 10k ohm Resistance Temperature Device (RTD) or thermistor.
   2. Duct Sensors. Duct sensors shall be single point or averaging as indicated or as required for the application. Averaging sensors shall be a minimum of 5 ft in length per 102 feet (3108.96 cm) of duct cross-section.
   3. Immersion Sensors. Provide immersion sensors with a separable stainless steel thermal well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
   4. Space Sensors. Space sensors shall have setpoint adjustment, override switch, display, and communication port as shown.

5. Differential Sensors. Provide matched sensors for differential temperature measurement.

F. Humidity Sensors.
   1. Duct and room sensors shall have a sensing range of 20%–80% RH.
   2. Duct sensors shall have a sampling chamber.
   3. Outdoor air humidity sensors shall have a sensing range of 20%–95% RH and shall be suitable for ambient conditions of -40°F to 170°F.
   4. Humidity sensors shall not drift more than 1% of full scale annually.

G. Relays.
   1. Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
   2. Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable ±100% from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

H. Override Timers.
   1. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0–6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.

I. Current Transmitters.
   1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4–20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be ±1% full-scale at 500 ohm maximum burden.
      a. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
      b. Unit shall be split-core type for clamp-on installation on existing wiring.

J. Current Transformers.
   1. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
   2. Transformers shall be available in various current ratios and shall be selected for ±1% accuracy at 5 A full-scale output.
   3. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

K. Voltage Transmitters.
   1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4–20 mA output with zero and span adjustment.
   2. Adjustable full-scale unit ranges shall be 100–130 Vac, 200–250 Vac, 250–330 Vac, and 400–600 Vac. Unit accuracy shall be ±1% full-scale at 500 ohm maximum burden.
   3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

L. Voltage Transformers.
   1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
   2. Transformers shall be suitable for ambient temperatures of 4°C–55°C (40°F–130°F) and shall provide ±0.5% accuracy at 24 Vac and 5 VA load.
   3. Windings (except for terminals) shall be completely enclosed with metal or plastic.

M. Power Monitors.

1. Selectable rate pulse output for kWh reading, 4–20 mA output for kW reading, N.O. alarm contact, and ability to operate with 5.0 amp current inputs or 0–0.33 volt inputs.
2. 1.0% full-scale true RMS power accuracy, +0.5 Hz, voltage input range 120–600 V, and auto range select.
3. Under voltage/phase monitor circuitry.
4. NEMA 1 enclosure.
5. Current transformers having a 0.5% FS accuracy, 600 VAC isolation voltage with 0–0.33 V output. If 0–5 A current transformers are provided, a three-phase disconnect/shorting switch assembly is required.

N. Current Sensing Relays (Current Switches).
1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

O. Pressure Transducers.
1. Transducers shall have linear output signal and field-adjustable zero and span.
2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
3. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 150 psi (1034.21 kPa). Transducer shall have 4–20 mA output, suitable mounting provisions, and block and bleed valves.
4. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 150 psi (1034.21 kPa). Over-range limit (differential pressure) and maximum static pressure shall be 300psi. Transducer shall have 4–20 mA output, suitable mounting provisions, and 5-valve manifold.

P. Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

Q. Pressure Switches.
1. Shall be metal or neoprene diaphragm actuated, operating pressure rated for application with calibrated local adjustment scale for setpoint range and UL listed.
2. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application. Electrically rated for pilot duty service (125 VA minimum) and/or for motor control.
3. Switches shall be open type (panel-mounted) or enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.

R. Flow Meters: Onicon F-3500 insertion magnetic flow meters only.

S. Local Control Panels
1. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
2. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.11 WIRING AND RACEWAYS

A. General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.

B. Insulated wire shall use copper conductors and shall be UL listed 200°F minimum service.

2.12 FIBER OPTIC CABLE SYSTEM

A. Optical Cable. Optical cables shall be duplex 35.43 inch (900 mm) tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.

B. Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal.

PART 3 INSTALLATION

3.01 EXAMINATION

A. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.

B. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made at the expense of—this contractor.

3.02 PROTECTION

A. The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.

B. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.03 COORDINATION

A. Site
   1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
   2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

B. Life Safety.
   1. Interlock smoke detectors to air handlers for shutdown where required by jurisdiction.

C. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:
   1. All communication media and equipment shall be provided
   2. Each supplier of a controls product is responsible for the configuration, programming, start up, and testing of that product to meet the sequences of operation.
   3. The contractor shall coordinate and resolve any incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.

4. The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
5. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.04 GENERAL WORKMANSHIP

1. Install equipment, piping, and wiring/raceway parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
2. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
3. Install equipment in readily accessible locations as defined by Chapter 1 Article 100 Part A of the National Electrical Code (NEC).
4. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
5. All equipment, installation, and wiring shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.05 FIELD QUALITY CONTROL

A. All work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances.

B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.

C. Contractor shall have work inspection by local and/or state authorities having jurisdiction over the work.

3.06 EXISTING EQUIPMENT

A. Wiring. Interconnecting control wiring shall be removed and shall become the property of the contractor unless specifically noted or shown to be reused.

B. Room Thermostats. Remove and deliver existing room thermostats to Owner unless otherwise noted. Patch and finish holes and marks left by removal to match existing walls.

C. The scheduling of fans through existing or temporary time clocks or control system shall be maintained throughout the DDC system installation

D. Patch holes and finish to match existing walls.

3.07 WIRING

A. All control and interlock wiring shall comply with national and local electrical codes, and Division 26 of this specification, Where the requirements of this section differ from Division 26, the requirements of this section shall take precedence.

B. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.

C. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.

D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended application.

E. All wiring in mechanical, electrical, or service rooms – or where subject to mechanical damage – shall be installed in raceway at levels below 3.28 yard (3 meter).

F. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

G. Do not install wiring in raceway containing tubing.

H. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3.28 yard (3 meter) (10 ft) intervals.

I. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.

J. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.

K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

L. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers.

M. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

N. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.

O. Size of raceway and size and type of wire type shall be the responsibility of the contractor in keeping with the manufacturer’s recommendations and NEC requirements, except as noted elsewhere.

P. Include one pull string in each raceway 1 inch (25.4 mm). or larger.

Q. Use color-coded conductors throughout with conductors of different colors.

R. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

1. Conceal all raceways except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 inch (152.4 mm). from high-temperature equipment (e.g. steam pipes or flues).
2. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
3. Adhere to this specification's Division 26 requirements where raceway crosses building expansion joints.
4. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of vertical raceways.
5. The contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
6. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 3 ft in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
7. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes and ends not terminating in boxes shall have bushings installed.

3.08 COMMUNICATION WIRING

A. The contractor shall adhere to the items listed in the "Wiring" article in Part 3 of the specification.

B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling

C. Do not install communication wiring in raceways and enclosures containing Class 1 or other Class 2 wiring.

D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.

F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to manufacturer’s instructions.

G. All runs of communication wiring shall be un-spliced length when that length is commercially available.

H. All communication wiring shall be labeled to indicate origination and destination data.

I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

J. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
   1. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 30 pF per foot.
   2. The maximum length of an MS/TP segment is 4000 ft with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
   3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
   4. An MS/TP EIA-485 network shall have no T connections.

3.09 FIBER OPTIC CABLE

A. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.

B. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

3.10 INSTALLATION OF SENSORS

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by wall framing.

D. All wires attached to sensors shall be sealed in their raceways or in the wall to stop air transmitted from other areas from affecting sensor readings.

E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed vertically across the duct in a serpentine manner. Each bend shall be supported with a capillary clip.

F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across the duct. Each bend shall be supported with a capillary clip. Provide 3.28 yard (3 meter) (1 ft) of sensing element for each 1 sq yard (1 sq m)12 feet (365.76 cm) of coil area.

G. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 3.28 yard (3 meter) (10 ft) downstream.

H. All pipe-mounted temperature sensors shall be installed in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.

I. Install outdoor air temperature sensors on the north wall, complete with sun shield at designated location.

J. Differential Air Static Pressure.
   1. Supply Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
   2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
   3. Building Static Pressure. Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
   4. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
   5. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
   6. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shut-off valves installed before the tee.

K. Smoke detectors, freeze-stats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

L. Not used

3.11 FLOW SWITCH INSTALLATION

1. Use correct paddle for pipe diameter.
2. Adjust flow switch according to manufacturer's instructions.

3.12 ACTUATORS

A. General. Mount and link control damper actuators according to manufacturer's instructions.
   1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open positions, manually close the damper, and then tighten the linkage.
   2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
   3. Provide all mounting hardware and linkages for actuator installation.

B. Electric/Electronic
   1. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° travel available for tightening the damper seal. Actuators shall be mounted following manufacturer’s recommendations.
   2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.13 WARNING LABELS

A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the control system.
   1. Labels shall use white lettering (12-point type or larger) on a red background.
   2. Warning labels shall read as follows.

C A U T I O N
THIS EQUIPMENT IS OPERATING UNDER AUTOMATIC CONTROL AND MAY START OR STOP AT ANY TIME WITHOUT WARNING. SWITCH DISCONNECT TO"OFF"POSITION BEFORE SERVICING.

A. Permanent warning labels shall be affixed to all motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.
   1. Labels shall use white lettering (12-point type or larger) on a red background.
   2. Warning labels shall read as follows.

C A U T I O N
THIS EQUIPMENT IS FED FROM MORE THAN ONE POWER SOURCE WITH SEPARATE DISCONNECTS. DISCONNECT ALL POWER SOURCES BEFORE SERVICING.

5.01 IDENTIFICATION OF HARDWARE AND WIRING

A. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 5 cm 2 inch (50.8 mm).) of termination with control system address or termination number.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum ½ in. letters on laminated plastic nameplates.

D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that label removal of the component does not remove the label.

E. Identify room sensors related to terminal boxes or valves with nameplates.

F. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.

G. Identifiers shall match record documents.

5.02 CONTROLLERS

A. Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.

B. Building Controllers and Custom Application Controllers shall be selected to provide the required I/O point capacity + 25% spare I/O point capacity for future use.

5.03 PROGRAMMING

A. Provide sufficient internal memory for the specified sequences of operation and trend logging.

B. Point Naming. Name points as shown on the equipment points list provided with each sequence of operation. See Section 23 09 93 (Sequences of Operation). If character limitations or space restrictions make it advisable to shorten the name, the abbreviations given in Appendix B to Section 23 09 93 may be used. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.

C. Software Programming.
   1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the contractor. Embed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
      a. Text-based:
         1) Must provide actions for all possible situations
         2) Must be modular and structured

3) Must be commented
b. Graphic-based:
1) Must provide actions for all possible situations
2) Must be documented
c. Parameter-based:
1) Must provide actions for all possible situations
2) Must be documented.

D. Operator Interface.
1. Standard Graphics. Provide graphics for all mechanical systems and floor plans of the building. This includes air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all relevant input and output points for that equipment. Also show relevant calculated points such as setpoints. As a minimum, show on each equipment graphic the input and output points and relevant calculated points as indicated on the applicable Points List in Section 23 09 93.
2. The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

5.04 CONTROL SYSTEM CHECKOUT AND TESTING

A. Startup Testing. All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.
1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops.
7. Alarms and Interlocks:
a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action

5.05 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration.
1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the

Contractor has completed the installation, started up the system, and performed his/her own tests.

2. The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The engineer will be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician’s initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1, "System Performance."
7. Demonstrate compliance with sequences of operation through all modes of operation.
8. Demonstrate complete operation of operator interface.
9. Additionally, the following items shall be demonstrated:
    a. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop’s response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
    b. Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.
    c. Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
    d. Interface to the building fire alarm system.
    e. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance.
    1. All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if

stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.

2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

5.06 CLEANING

A. The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

5.07 TRAINING

A. Provide training for a designated staff of Owner’s representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.

B. Training shall enable students to accomplish the following objectives.
   1. Day-to-day Operators:
      a. Proficiently operate the system
      b. Understand control system architecture and configuration
      c. Understand DDC system components
      d. Understand system operation, including DDC system control and optimizing routines (algorithms)
      e. Operate the workstation and peripherals
      f. Log on and off the system
      g. Access graphics, point reports, and logs
      h. Adjust and change system set points, time schedules, and holiday schedules
      i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
      j. Understand system drawings and Operation and Maintenance manual
      k. Understand the job layout and location of control components
      l. Access data from DDC controllers and ASCs
      m. Operate portable operator's terminals
   2. Advanced Operators:
      a. Make and change graphics on the workstation
      b. Create, delete, and modify alarms, including annunciation and routing of these
      c. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
      d. Create, delete, and modify reports
      e. Add, remove, and modify system's physical points
      f. Create, modify, and delete programming
      g. Add panels when required
      h. Add operator interface stations
      i. Create, delete, and modify system displays, both graphical and others
      j. Perform DDC system field checkout procedures
      k. Perform DDC controller unit operation and maintenance procedures
      l. Perform workstation and peripheral operation and maintenance procedures
      m. Perform DDC system diagnostic procedures

n. Configure hardware including PC boards, switches, communication, and I/O points
o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
p. Adjust, calibrate, and replace system components

3. System Managers/Administrators:
   a. Maintain software and prepare backups
   b. Interface with job-specific, third-party operator software
   c. Add new users and understand password security procedures

C. Organize the training into sessions or modules for the three levels of operators listed above. (Day-to-Day Operators, Advanced Operators, System Managers and Administrators). Students will receive one or more of the training packages, depending on knowledge level required.

D. Provide course outline and materials according to the "Submittals" article in Part 1 of this specification. Provide one copy of training material per student.

E. The instructor(s) shall be factory-trained and experienced in presenting this material.

F. Classroom training shall be done using a network of working controllers representative of installed hardware.

5.08 SEQUENCES OF OPERATION

A. Refer to drawings

5.09 CONTROL DAMPER INSTALLATION

A. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.

B. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure ¼ in. larger than damper dimensions and shall be square, straight, and level.

C. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 0.3 cm 1/8 inch (3.18 mm).) of each other.

D. Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.

E. Install extended shaft or jackshaft according to manufacturer’s instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)

F. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.

G. Provide a visible and accessible indication of damper position on the drive shaft end.

H. Support ductwork in area of damper when required to prevent sagging due to damper weight.

I. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

5.10 DUCT SMOKE DETECTION

A. Submit data for coordination of duct smoke detector interface to HVAC systems as required in Part 1, "Submittals."

B. This Contractor shall provide a dry-contact alarm output in the same room as the HVAC equipment to be controlled.

5.11 PACKAGED EQUIPMENT CONTROLS

A. General. The electronic controls packaged with any equipment furnished under this contract shall communicate with the building direct digital control (DDC) system. The DDC system shall communicate with these controls to read the information and change the control setpoints as shown in the points list, sequences of operation, and control schematics. The information to be communicated between the DDC system and these controls shall be in the standard object format as defined in ANSI/ASHRAE Standard 135 (BACnet). Controllers shall communicate with other BACnet objects on the internetwork using the Read (Execute) Property service as defined in Clause 15.5 of Standard 135.

B. Distributed Processing. The controller shall be capable of stand-alone operation and shall continue to provide control functions if the network connection is lost.

C. I/O Capacity. The controller shall contain sufficient I/ O capacity to control the target system.

D. The Controller shall have a physical connection for a laptop computer or a portable operator's tool.

E. Environment. The hardware shall be suitable for the anticipated ambient conditions.
   1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 40°F to 140°F.
   2. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 32°F to 120°F.

F. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.

G. Memory. The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 30 days.

H. Power. Controller shall be able to operate at 90% to 110% of nominal voltage rating.

I. Transformer. Power supply for the Controller must be rated at minimum of 125% of ASC power consumption and shall be fused or current limiting type.

5.12 START-UP AND CHECKOUT PROCEDURES

A. Start up, check out, and test all hardware and software and verify communication between all components.
   1. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
   2. Verify that all analog and binary input/output points read properly.
   3. Verify alarms and interlocks.
   4. Verify operation of the integrated system.

END OF SECTION

SECTION 232300
REFRIGERANT PIPING

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 GENERAL

3.01 REFERENCE STANDARDS

A. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers; 2005.

B. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).

C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.

D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.

E. ASME B16.50 - Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings; 2021.

F. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2022.

G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

H. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2026.

I. ASTM B32 - Standard Specification for Solder Metal; 2020.

J. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.

K. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.

L. AWS D10.12M/D10.12 - Guide for Welding Mild Steel Pipe; 2000.

M. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

N. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

O. UL 429 - Electrically Operated Valves; Current Edition, Including All Revisions.

3.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

3.03 SUMMARY

A. Section Includes:
   1. Copper tube and fittings.
   2. Steel pipe and fittings.
   3. Valves and specialties.
   4. Refrigerants.

3.04 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, and piping specialty.
   1. Include pressure drop, based on manufacturer's test data, for the following:
      a. Thermostatic expansion valves.
      b. Solenoid valves.
      c. Hot-gas bypass valves.
      d. Filter dryers.
      e. Strainers.

f. Pressure-regulating valves.

B. Sustainable Design Submittals:

C. Shop Drawings:
1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
3. Show interface and spatial relationships between piping and equipment.
4. Shop Drawing Scale: 1/4 inch (6.35 mm) equals 1 foot (30.48 cm).

3.05 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

3.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

3.07 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

3.08 PRODUCT STORAGE AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 PRODUCTS

4.01 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-134a:
1. Suction Lines for Air-Conditioning Applications: 115 psig (792.90 kPa).
2. Suction Lines for Heat-Pump Applications: 225 psig (1551.32 kPa).
3. Hot-Gas and Liquid Lines: 225 psig (1551.32 kPa).

B. Line Test Pressure for Refrigerant R-407C:
1. Suction Lines for Air-Conditioning Applications: 230 psig (1585.79 kPa).
2. Suction Lines for Heat-Pump Applications: 380 psig (2620.01 kPa).
3. Hot-Gas and Liquid Lines: 380 psig (2620.01 kPa).

C. Line Test Pressure for Refrigerant R-410A:
1. Suction Lines for Air-Conditioning Applications: 300 psig (2068.43 kPa).
2. Suction Lines for Heat-Pump Applications: 535 psig (3688.70 kPa).
3. Hot-Gas and Liquid Lines: 535 psig (3688.70 kPa).

4.02 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B88, Type K or L.

B. Wrought-Copper Fittings, Solder-Joint: ASME B16.22.

C. Wrought-Copper Fittings, Brazed-Joint: ASME B16.50.

D. Wrought-Copper Unions: ASME B16.22.

E. Solder Filler Metals: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

F. Brazing Filler Metals: AWS A5.8/A5.8M.

G. Flexible Connectors:
   1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
   2. End Connections: Socket ends.
   3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
   4. Working Pressure Rating: Factory test at minimum 500 psig (3447.38 kPa).
   5. Maximum Operating Temperature: 250 deg F.

H. Copper-Tube, Pressure-Seal-Joint Fittings for Refrigerant Piping:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conex Banninger - USA.
      b. Parker Hannifin, Sporlan Division.
   2. Standard: UL 207; certified by UL for field installation. Certification as a UL-recognized component alone is unacceptable.
   3. Housing: Copper.
   4. O-Rings: HNBR or compatible with specific refrigerant.
   5. Tools: Manufacturer's approved special tools.
   6. Minimum Rated Pressure: 700 psig (4826.33 kPa).

4.03 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; type, grade, and wall thickness as selected in piping application articles.

B. Wrought-Steel Fittings: ASTM A234/A234M, for welded joints.

C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.

D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

E. Flanged Unions:
   1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 and ductile iron for NPS 2 to NPS 3. Apply rust-resistant finish at factory.
   2. Gasket: Fiber asbestos free.
   3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
   4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
   5. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
   6. Pressure Rating: Factory test at minimum 400 psig (2757.90 kPa).
   7. Maximum Operating Temperature: 330 deg F.

F. Flexible Connectors:
   1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket.
   2. End Connections:
      a. NPS 2 and Smaller: With threaded-end connections.
      b. NPS 2-1/2 and Larger: With flanged-end connections.
   3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.

4. Pressure Rating: Factory test at minimum 500 psig (3447.38 kPa).
5. Maximum Operating Temperature: 250 deg F.

4.04 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss Inc.
   b. Heldon Products; Henry Technologies.
   c. Parker Hannifin Corp.
   d. Paul Mueller Company.
2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
3. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
4. Operator: Rising stem and hand wheel.
5. Seat: Nylon.
6. End Connections: Socket, union, or flanged.
7. Working Pressure Rating: 500 psig (3447.38 kPa).
8. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss Inc.
   b. Heldon Products; Henry Technologies.
   c. Parker Hannifin Corp.
   d. Paul Mueller Company.
2. Body and Bonnet: Forged brass or cast bronze.
3. Packing: Molded stem, back seating, and replaceable under pressure.
4. Operator: Rising stem.
5. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
6. Seal Cap: Forged-brass or valox hex cap.
7. End Connections: Socket, union, threaded, or flanged.
8. Working Pressure Rating: 500 psig (3447.38 kPa).
9. Maximum Operating Temperature: 275 deg F.

C. Check Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. Danfoss Inc.
   c. Emerson Climate Technologies.
   d. Heldon Products; Henry Technologies.
   e. Parker Hannifin Corp.
   f. Paul Mueller Company.
2. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
3. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
4. Piston: Removable polytetrafluoroethylene seat.
5. Closing Spring: Stainless steel.
6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
7. End Connections: Socket, union, threaded, or flanged.
8. Maximum Opening Pressure: 0.50 psig (0.00 kPa).
9. Working Pressure Rating: 500 psig (3447.38 kPa).

10. Maximum Operating Temperature: 275 deg F.

D. Service Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Danfoss Inc.
      b. Emerson Climate Technologies.
      c. Heldon Products; Henry Technologies.
      d. Parker Hannifin Corp.
      e. Paul Mueller Company.
      f. RectorSeal HVAC; a CSW Industrials Company.
      g. Refrigeration Sales, Inc.
   2. Body: Forged brass with brass cap including key end to remove core.
   3. Core: Removable ball-type check valve with stainless-steel spring.
   4. Seat: Polytetrafluoroethylene.
   5. End Connections: Copper spring.
   6. Working Pressure Rating: 500 psig (3447.38 kPa).

E. Refrigerant Locking Caps:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. C & D Valve, LLC.
      b. JB Industries.
      c. RectorSeal HVAC; a CSW Industrials Company.
   2. Description: Locking-type, tamper-resistant, threaded caps to protect refrigerant charging ports from unauthorized refrigerant access and leakage.
   3. Material: Brass, with protective shroud or sleeve.
   4. Refrigerant Identification: Color-coded, refrigerant specific orUniversaldesign.
   5. Special Tool: For installing and unlocking.

F. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Danfoss Inc.
      b. Emerson Climate Technologies.
      c. Heldon Products; Henry Technologies.
      d. Parker Hannifin Corp.
      e. Paul Mueller Company.
   2. Body and Bonnet: Plated steel.
   3. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
   4. Seat: Polytetrafluoroethylene.
   5. End Connections: Threaded.
   6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
   7. Working Pressure Rating: 400 psig (2757.90 kPa).
   8. Maximum Operating Temperature: 240 deg F.

G. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Danfoss Inc.
      b. Heldon Products; Henry Technologies.
      c. Parker Hannifin Corp.

d. Paul Mueller Company.
2. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
3. Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Threaded.
6. Working Pressure Rating: 400 psig (2757.90 kPa).
7. Maximum Operating Temperature: 240 deg F.

H. Thermostatic Expansion Valves: Comply with AHRI 750.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Danfoss Inc.
b. Emerson Climate Technologies.
c. Heldon Products; Henry Technologies.
d. Paul Mueller Company.
2. Body, Bonnet, and Seal Cap: Forged brass or steel.
3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Packing and Gaskets: Non-asbestos.
5. Capillary and Bulb: Copper tubing filled with refrigerant charge.
6. Suction Temperature: 40 deg F.
7. Superheat: Adjustable.
8. Reverse-flow option (for heat-pump applications).
9. End Connections: Socket, flare, or threaded union.
10. Working Pressure Rating: 700 psig (4826.33 kPa).

I. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Danfoss Inc.
b. Heldon Products; Henry Technologies.
c. Parker Hannifin Corp.
2. Body, Bonnet, and Seal Cap: Ductile iron or steel.
3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Packing and Gaskets: Non-asbestos.
5. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
6. Seat: Polytetrafluoroethylene.
7. Equalizer: Internal.
8. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and 24-V ac coil.
9. End Connections: Socket.
10. Set Pressure: ???Insert psig???.
11. Throttling Range: Maximum 5 psig (34.47 kPa).
12. Working Pressure Rating: 500 psig (3447.38 kPa).
13. Maximum Operating Temperature: 240 deg F.

J. Straight-Type Strainers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Danfoss Inc.
b. Heldon Products; Henry Technologies.
c. Parker Hannifin Corp.
2. Body: Welded steel with corrosion-resistant coating.
3. Screen: 100-mesh stainless steel.
4. End Connections: Socket or flare.

5. Working Pressure Rating: 500 psig (3447.38 kPa).
6. Maximum Operating Temperature: 275 deg F.

K. Angle-Type Strainers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss Inc.
   b. Heldon Products; Henry Technologies.
   c. Parker Hannifin Corp.
2. Body: Forged brass or cast bronze.
3. Drain Plug: Brass hex plug.
4. Screen: 100-mesh monel.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig (3447.38 kPa).
7. Maximum Operating Temperature: 275 deg F.

L. Moisture/Liquid Indicators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss Inc.
   b. Emerson Climate Technologies.
   c. Heldon Products; Henry Technologies.
   d. Parker Hannifin Corp.
2. Body: Forged brass.
3. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
4. Indicator: Color coded to show moisture content in parts per million (ppm).
5. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
6. End Connections: Socket or flare.
7. Working Pressure Rating: 500 psig (3447.38 kPa).
8. Maximum Operating Temperature: 240 deg F.

M. Replaceable-Core Filter Dryers: Comply with AHRI 730.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss Inc.
   b. Emerson Climate Technologies.
   c. Heldon Products; Henry Technologies.
   d. Parker Hannifin Corp.
2. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Desiccant Media: Activated alumina.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig (13.79 kPa).
9. Rated Flow: ???Insert tons???.
10. Working Pressure Rating: 500 psig (3447.38 kPa).
11. Maximum Operating Temperature: 240 deg F.

N. Permanent Filter Dryers: Comply with AHRI 730.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss Inc.
   b. Emerson Climate Technologies.
   c. Heldon Products; Henry Technologies.
   d. Parker Hannifin Corp.
2. Body and Cover: Painted-steel shell.
3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Desiccant Media: Activated alumina.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig (13.79 kPa).
9. Rated Flow: ???Insert tons???.
10. Working Pressure Rating: 500 psig (3447.38 kPa).
11. Maximum Operating Temperature: 240 deg F.

O. Mufflers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss Inc.
   b. Emerson Climate Technologies.
   c. Heldon Products; Henry Technologies.
2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig (3447.38 kPa).
5. Maximum Operating Temperature: 275 deg F.

P. Receivers: Comply with AHRI 495.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Heldon Products; Henry Technologies.
2. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
3. Comply with UL 207; listed and labeled by an NRTL.
4. Body: Welded steel with corrosion-resistant coating.
5. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
6. End Connections: Socket or threaded.
7. Working Pressure Rating: 500 psig (3447.38 kPa).
8. Maximum Operating Temperature: 275 deg F.

Q. Liquid Accumulators: Comply with AHRI 495.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Emerson Climate Technologies.
   b. Heldon Products; Henry Technologies.
   c. Parker Hannifin Corp.
2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or threaded.
4. Working Pressure Rating: 500 psig (3447.38 kPa).
5. Maximum Operating Temperature: 275 deg F.

4.05 REFRIGERANTS

A. ASHRAE 34, R-134a: Tetrafluoroethane.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Arkema Inc.
      b. DuPont Fluorochemicals Div.
      c. Genetron Refrigerants; Honeywell International Inc.
      d. Mexichem Fluor Inc.

B. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Arkema Inc.
      b. DuPont Fluorochemicals Div.
      c. Genetron Refrigerants; Honeywell International Inc.
      d. Mexichem Fluor Inc.

C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Arkema Inc.
      b. DuPont Fluorochemicals Div.
      c. Genetron Refrigerants; Honeywell International Inc.
      d. Mexichem Fluor Inc.

PART 3 EXECUTION

5.01 PIPING APPLICATIONS FOR REFRIGERANT R-134A

A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type K, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Suction Lines NPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type K, drawn-temper tubing and wrought-copper fittings with joints.

C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
   1. Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
   2. Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.

D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, Multiple Tube Types and Joining Methods:
   1. NPS 1-1/2 and Smaller, Type ACR, Annealed Temper: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
   2. NPS 1-1/2 and Smaller: Copper, Type K, drawn-temper tubing and wrought-copper fittings with brazed joints.
   3. NPS 4: Copper, Type K, drawn-temper tubing and wrought-copper fittings with brazed joints.

E. Safety-Relief-Valve Discharge Piping, Steel: Schedule 40, black-steel and wrought-steel fittings with welded joints.

F. Safety-Relief-Valve Discharge Piping, Copper: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.

G. Safety-Relief-Valve Discharge Piping, Multiple Tube Types and Joining Methods:
   1. NPS 1-1/2 and Smaller, Type ACR, Annealed Temper: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

2. NPS 1-1/2 and Smaller: Copper, Type K, drawn-temper tubing and wrought-copper fittings with brazed joints.
3. NPS 4: Copper, Type K, drawn-temper tubing and wrought-copper fittings with brazed joints.

5.02 PIPING APPLICATIONS FOR REFRIGERANT R-407C

A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Suction Lines NPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type K, drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
1. Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
2. Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.

D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, Multiple Tube Types and Joining Methods:
1. NPS 1 and Smaller, Type ACR, Annealed Temper: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
2. NPS 1 and Smaller: Copper, Type K, drawn-temper tubing and wrought-copper fittings with brazed joints.
3. NPS 1-1/4 to NPS 2: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
4. NPS 4: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.

E. Safety-Relief-Valve Discharge Piping, Steel: Schedule 40, black-steel and wrought-steel fittings with welded joints.

F. Safety-Relief-Valve Discharge Piping, Copper: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.

G. Safety-Relief-Valve Discharge Piping, Multiple Tube Types and Joining Materials:
1. NPS 1 and Smaller, Type ACR, Annealed Temper: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
2. NPS 1 and Smaller: Copper, Type K, drawn-temper tubing and wrought-copper fittings with brazed joints.
3. NPS 1-1/4 to NPS 2: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
4. NPS 4: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.

5.03 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 1-1/2 and Smaller Insert pipe size range for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazedorsolderedjoints.

B. Suction Lines NPS 2 to NPS 3-1/2 for Conventional Air-Conditioning Applications: Copper, Type K, drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.

D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
1. Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
2. Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3. Copper, Type L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
4. Copper, Type L, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, Multiple Tube Types and Joining Methods:
1. NPS 5/8 and Smaller: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
2. NPS 3/4 to NPS 1 and Smaller: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
3. NPS 1-1/4 and Smaller: Copper, Type K, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
4. NPS 1-1/2 to NPS 2: Copper, Type K, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
5. NPS 2 to NPS 4: Schedule 40, black-steel and wrought-steel fittings with welded joints.

F. Safety-Relief-Valve Discharge Piping:
1. Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
2. Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazedsolderedjoints.
3. Copper, Type K, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
4. Copper, Type K, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

G. Safety-Relief-Valve Discharge Piping, Multiple Tube Sizes and Joining Materials:
1. NPS 5/8 and Smaller: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
2. NPS 3/4 to NPS 1 and Smaller: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
3. NPS 1-1/4 and Smaller: Copper, Type K, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
4. NPS 1-1/2 to NPS 2: Copper, Type K, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
5. NPS 2 to NPS 4: Schedule 40, black-steel and wrought-steel fittings with welded joints.

5.04 VALVE AND SPECIALTY APPLICATIONS

A. Install packed-angle valves in suction and discharge lines of compressor.

B. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install packed-angle valves on inlet and outlet side of filter dryers.

E. Install a full-size, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.

3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

N. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to the authority having jurisdiction.

5.05 INSTALLATION OF PIPING, GENERAL

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
   1. Shot blast the interior of piping.
   2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
   3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
   4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
   5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
   6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

S. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

5.06 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12.

I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

5.07 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic restraints in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (609.6 cm) long.
   2. Roller hangers and spring hangers for individual horizontal runs 20 feet (609.6 cm) or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (609.6 cm) or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

D. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within 12 inches (304.8 mm) of each fitting.

F. Support vertical runs of copper tubing Typeto comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

5.08 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
      c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

5.09 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (13.79 kPa).
   4. Charge system with a new filter-dryer core in charging line.

5.10 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 233100
NON-FIBROUS, CLOSED CELL, OUTDOOR / INDOOR DUCTWORK

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method; 2023, with Editorial Revision (2024).

B. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

C. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2025.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

E. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2027.

G. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2027.

H. SMACNA (Phenolic) - Phenolic Duct Construction Standards; 2015.

I. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.02 SECTION INCLUDES:

A. Pro-R® Rectangle, Factory Manufactured Pre-Insulated Duct, by Ducts and Cleats

1.03 SUBMITTALS:

A. Product data: For each type of product indicated.

B. Shop drawings: Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work including:
   1. Duct layout indicating sizes and pressure classes
   2. Elevation of top of ducts
   3. Dimensions of main duct runs from building grid lines
   4. Fittings
   5. Penetrations through fire-rated and other partitions
   6. Color – selected by Architect / Owner / Engineer

C. Coordination Drawings: Plans, drawn to scale, showing coordination general construction building components, and other building services.

1.04 QUALITY ASSURANCE:

A. Installer Qualifications:
   1. Pro-R® shall be installed by field mechanics who have completed the installation training.
   2. Have working knowledge of SMACNA (Phenolic) Duct Construction Standards ANSI-22-2015

1.05 SPECIFICATION COMPLIANCE:

A. NFPA Compliance:
   1. NFPA 90A, “Installation of Air Conditioning and Ventilating Systems”
   2. NFPA 90B, “Installation of Warm Air Heating and Air Conditioning Systems”

3. NFPA 255, “Stanton and her Method of Test of Surface Burning Characteristics of Building Materials”

B. Inner Liner: UL (C-UL) 181 Standard for Safety listed, Class 1 System, with included testing and passing the following:
   1. Test for Surface Burning Characteristics
   2. Flame Penetration Test
   3. Burning Test
   4. Mold Growth and Humidity Test
   5. Low Temperature Test and High Temperature Test
   6. Puncture Test
   7. Impact Test
   8. Pressure Test and Collapse (negative pressure) Test
   9. High Temperature and Humidity for 90 days
   10. Cone Calorimeter
   11. ASTM E2257 Standard Test Method for Room Fire Test of Wall & Ceiling Materials & Assemblies
   12. ASTM E84 / UL 723, Tunnel Test, does not exceed 25 flame spread, 50 smoke developed.
   13. DW144, Class B
   14. NRTL product approval, (Subpart S of 29 CFR Part 1910, OSHA)
   15. ASTM C423 noise reduction
   16. ASTM E96/E96M Procedure A for permeability
   17. ASTM C1071 for erosion
   18. ASTM C518: 2004, Standard Test Method for Steady–State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

1.06 PRODUCT DELIVERY AND STORAGE:

A. Prevent objectionable aesthetic damage to the outer surface of duct segments during transport and storage. Store duct segments under cover and protect from the environment.

PART 1 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Pro-R® Rectangle Ductwork System by Ducts and Cleats; 200 West Plato Blvd, St. Paul, MN 55107; Tel: (651)-265-0605; Email; info@ductsandcleats.com; Web; www.prorduct.com
   1. Duct Panel Core: Aluminum Foil Scrim Phenolic Foam Ductwork
      a. Closed Cell CFC-free phenolic foam bonded on both sides with factory applied 0.001-inch-thick aluminum foil reinforced with fiberglass scrim.
      b. Maximum Temperature: 185℉ inside ducts or ambient temperature surrounding ducts.
      c. Maximum Thermal Conductivity: 0.146 Btu · in/hr · sq. ft · deg F at 75℉ mean temperature.
      d. Permeability: 0.0002 perms maximum when tested according to ASTM E96/E96M, Procedure A.
      e. Antimicrobial Agent: Compound shall be tested for efficacy by an NRTL, and registered by the EPA for use in HVAC systems.
      f. Noise-Reduction Coefficient: 0.65 minimum when tested according to ASTM C423, Mounting A.
      g. Phenolic duct shall be built to SMACNA Construction Standards for Phenolic Duct ANSI 22-2015.
   2. Pressure Class: Pro-R® Rectangle can be constructed to pressure classes from -10" up to 10” w.g.

3. Air Leakage: Better than Class 3 @ 2” w.g.
4. Weight: R8 Pro-R® shall have a maximum weight range of 1 – 1.6 lbs / sq. ft.
5. Duct Wall Nominal Thickness Per R-Value:
    a. R-8: 1 1/2 inch (12.7 mm) Thick
    b. R-12: 2 inch (50.8 mm) Thick
    c. R-16: 2 1/2 inch (12.7 mm) Thick
    d. R-20: 3 inch (76.2 mm) Thick
    e. R-24: 4 inch (101.6 mm) Thick

B. Exterior Cladding:
1. Metal
    a. G90 Embossed Galvanized
    b. 0.040” (18 gauge) minimum thickness SMF embossed aluminum
    c. Kynar Coated Aluminum Alternate Options. Color: as selected by Architect / Owner / Engineer during submittals (over 20 colors available).
2. Completed duct sections shall have no through penetrations of exterior cladding.
3. Exterior cladding and joint connection covers shall have an ASTM E84 rating that does not exceed 25 flame spread, 50 smoke developed.
4. Exterior cladding shall utilize sealed longitudinal Pittsburgh seams.

PART 2 EXECUTION

3.01 SHOP FABRICATION:

A. Certification:
1. Duct shall be detailed and fully factory manufactured by Pro-R® facility system guidelines. All fabrication labor will be certified “yellow label” building trade professionals, compliant to SMWIA and SMACNA labor guidelines.

B. Fabrication Guidelines:
1. Joints, seams, transitions, reinforcement, elbows, branch connections, access doors and panels, and damage repairs fabricated according to manufacturer’s written and detailed instructions and per SMACNA Construction Standards for Phenolic Duct ANSI 22
2. Fabricated 90-degree mitered elbows to include turning vanes.
3. Duct segments will be fabricated in accordance with manufacturer’s written details.
4. Duct segments utilizing v-groove method of fabrication. Pittsburgh seams will apply to fully manufactured ductwork and fittings. Internal seams will be supplied with an unbroken layer of low VOC silicone or bonding. Each duct segment will be factory supplied with TDC flange in accordance with manufacturer’s Quick Start Guide. Duct reinforcement to protect against side deformation from both positive and negative pressure per manufacturer’s design guide based on specified ductwork size and system pressure.
5. Duct segments and fittings will be in accordance with “SMACNA (Phenolic) Standards” and “SMACNA HVAC Duct Construction Standards” latest edition.
6. Both positive and negative duct and fittings shall be constructed to incorporate a UL Listed as a Class 1 air duct to Standard for Safety UL 181 liner.

3.02 DUCT INSTALLATION:

A. Duct segments shall be installed by competent HVAC installers.

B. Install ducts and fittings to comply with manufacturers detailed drawing submittal as follows:
1. Install ducts with fewest possible joints
2. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
3. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA’s “Duct Cleanliness for New Construction Guidelines.”

4. Air Leakage: Duct air leakage rates shall be in compliance with “SMACNA HVAC” without sealant, caulk or other liquid duct sealer.
5. For outdoor installations, ProCap flange covers shall be installed according to manufacturer guidelines and without the requirement of sealant, caulk or duct sealer.
6. Joint connections and flange covers will be free of sealant or caulk exposed to the elements.

3.03 HANGER AND SUPPORT INSTALLATION:

A. Contractor to ensure that the ductwork system is properly and adequately supported.
1. Ensure that the chosen method is compatible with the specific ductwork system per Pro-R® installation detail drawings provided prior to work commencement.
2. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
3. Support and use appropriate hanging material according to SMACNA standards and local mechanical code and taking into account any snow load and wind uplift.
4. Supports on straight runs of ductwork shall be positioned at centers not exceeding 8 feet (243.84 cm) for duct sections with a girth greater than 88 inches (2235.2 mm). For duct with girth greater than 240”, supports not to exceed 6 feet (182.88 cm). Smaller ductwork with a girth less than or equal to 88” shall not exceed 13 feet (396.24 cm).
5. Ductwork shall be supported at changes of direction, at branch duct connections, tee fittings, and all duct accessories such as dampers, etc. per SMACNA standards.
6. The load of such accessories to the ductwork shall be neutralized by the accessory support.

3.04 FIELD QUALITY CONTROL:

1. Inspection: Contractor to review manufacturer installation guidelines for proper installation.

3.05 DUCT SCHEDULE:

1. Outdoor Ducts and Fittings: Pro-R® Rectangular Ducts and Fittings
   a. Minimum Insulation Thickness: 1.18 inch (30 mm)
   b. Metal Exterior Cladding: minimum thickness of 0.040” (18 gauge)

3.06 APPROVED ALTERNATES:

1. Phenolic duct alternates only, if approved prior to bid date. Must be built per SMACNA Standards for Phenolic Duct fabrication ANSI-22 (NO EXCEPTIONS) with no penetrations to the external cladding unless sloped. SMACNA Approved jacketing for exterior application required. Exterior cladding and connection covers must have a flame/smoke rating of 25/50 or less as per ASTM E84. Any Systems with penetrations to the external jacket and/or requiring field applied sealant or overlapped adhesives must be fabricated by the manufacturer with a sloped roof of ¼” per 12”, side to side or gable peak.
   a. Any Phenolic or KoolDuct – Approved Jacketing min .032 Aluminum, Sloped roof of ¼” per 12” required
   b. Thermaduct – Sloped roof of ¼” per 12” required
   c. Dual Tech – Sloped roof of ¼” per 12” required
2. Insulated metal is not allowed.

END OF SECTION

SECTION 233113
METAL DUCTS

SECTION 23 31 13

METAL DUCTS

PART 1 GENERAL

3.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

3.02 SUMMARY

A. Section Includes:
   1. Single-wall rectangular ducts and fittings.
   2. Double-wall rectangular ducts and fittings.
   3. Single-wall round and flat-oval ducts and fittings.
   4. Double-wall round and flat-oval ducts and fittings.
   5. Sheet metal materials.
   6. Duct liner.
   7. Sealants and gaskets.
   8. Hangers and supports.

B. Related Sections:
   1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
   2. Section 233116 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
   3. Section 233119 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
   4. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

3.03 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning and Development (State of California).

3.04 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

B. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2025b.

C. ASTM A492 - Standard Specification for Stainless Steel Rope Wire; 1995 (Reapproved 2019).

D. ASTM A603 - Standard Specification for Metallic-Coated Steel Structural Wire Rope; 2019.

E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

F. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2026.

G. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

H. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2026.

I. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2020.

J. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).
K. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2025.
L. ASTM D3363 - Standard Test Method for Film Hardness by Pencil Test; 2022.
M. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.
N. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).
O. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; 2026.
P. AWS D9.1/D9.1M - Sheet Metal Welding Code; 2026.
Q. NADCA ACR - The NADCA Standard for Assessment, Cleaning, and Restoration of HVAC Systems; 2025.
R. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2027.
S. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2027.
T. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2027.
U. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.
V. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

3.05 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.
   3. Seismic-restraint devices.
B. Sustainable Design Submittals:
C. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
   4. Elevation of top and bottom of ducts.
   5. Dimensions of all ducts runs from building grid lines.
   6. Fittings.
   7. Reinforcement and spacing.
   8. Seam and joint construction.
   9. Penetrations through fire-rated and other partitions.
   10. Equipment installation based on equipment being used on Project.
   11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
   12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
D. Delegated-Design Submittal:
   1. Sheet metal thicknesses.
   2. Joint and seam construction and sealing.
   3. Reinforcement details and spacing.
   4. Materials, fabrication, assembly, and spacing of hangers and supports.

5. Design Calculations: Calculations for selecting hangers and supports.

3.06 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Welding certificates.

C. Field quality-control reports.

3.07 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
   3. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Mockups:
   1. Before installing duct systems, build mockups representing static-pressure classes in excess of 3 inch (76.2 mm) wg. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
      a. Five transverse joints.
      b. One access door(s).
      c. Two typical branch connections, each with at least one elbow.
      d. Two typical flexible duct or flexible-connector connections for each duct and apparatus.
      e. One 90-degree turn(s) with turning vanes.
      f. One fire damper(s).
      g. Perform leakage tests specified in "Field Quality Control" Article. Revise mockup construction and perform additional tests as required to achieve specified minimum acceptable results.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 PRODUCTS

4.01 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

F. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

4.02 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
   1. Construct ducts of galvanized sheet steel unless otherwise indicated.
   2. For ducts exposed to weather, construct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. For ducts with longest side less than 36 inches (914.4 mm), select joint types in accordance with Figure 2-1.
   2. For ducts with longest side 36 inches (914.4 mm) or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
   3. Where specified for specific applications, all joints shall be welded.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.
   1. Where specified for specific applications, all joints shall be welded.

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

4.03 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. McGill AirFlow LLC.
   2. MKT Metal Manufacturing.
   3. Set Duct Manufacturing.
   4. Sheet Metal Connectors, Inc.

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for clear internal dimensions of the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
   1. Construct ducts of galvanized sheet steel unless otherwise indicated.
   2. For ducts exposed to weather, construct outer duct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.

D. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. For ducts with longest side less than 36 inches (914.4 mm), select joint types in accordance with Figure 2-1.

2. For ducts with longest side 36 inches (914.4 mm) or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
3. Where specified for specific applications, all joints shall be welded.

E. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.
1. Where specified for specific applications, all joints shall be welded.

F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

G. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C534/C534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

H. Inner Duct: Minimum 24-gauge solid galvanized sheet steel.

4.04 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.
3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ductmate Industries, Inc.
   b. Elgen Manufacturing.
   c. Linx Industries (formerly Lindab).
   d. McGill AirFlow LLC.
   e. MKT Metal Manufacturing.
   f. Nordfab Ducting.
   g. SEMCO, LLC; part of FlaktGroup.
   h. Set Duct Manufacturing.
   i. Sheet Metal Connectors, Inc.
   j. Spiral Manufacturing Co., Inc.
   k. Stamped Fittings Inc.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support

intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
   2. Fabricate flat-oval ducts larger than 72 inches (1828.8 mm) in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

4.05 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS (TO BE USED FOR ALL AREA WITHOUT CEILING)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Linx Industries (formerly Lindab).
   2. McGill AirFlow LLC.
   3. MKT Metal Manufacturing.
   4. SEMCO, LLC; part of FlaktGroup.
   5. Set Duct Manufacturing.
   6. Sheet Metal Connectors, Inc.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
   1. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
      a. Construct ducts of galvanized sheet steel unless otherwise indicated.
      b. For ducts exposed to weather, construct outer duct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.
   2. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
      a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
   3. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
      a. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
      b. Fabricate flat-oval ducts larger than 72 inches (1828.8 mm) in width (major dimension) with butt-welded longitudinal seams.

4. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Inner Duct: Minimum 24-gauge solid galvanized sheet steel.

D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

E. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C534/C534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

4.06 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A653/A653M.
1. Galvanized Coating Designation: G90.
2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils (0.1016 mm) thick.
3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.

E. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.

F. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Factory- or Shop-Applied Antimicrobial Coating:
1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested in accordance with ASTM D3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
5. Shop-Applied Coating Color: White.

6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

H. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

I. Tie Rods: Galvanized steel, 1/4-inch-minimum diameter for lengths 36 inches (914.4 mm) or less; 3/8-inch-minimum diameter for lengths longer than 36 inches.

4.07 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corporation; Saint-Gobain North America.
      b. Johns Manville; a Berkshire Hathaway company.
      c. Knauf Insulation.
      d. Owens Corning.
   2. Maximum Thermal Conductivity:
      a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
      b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
   3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
   4. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Aeroflex USA.
      b. Armacell LLC.
      c. Ductmate Industries, Inc.
      d. K-Flex USA.
   2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
   3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

C. Fiberglass-Free Duct Liner: Made from partially recycled cotton or polyester products and containing no fiberglass. Airstream surface overlaid with fire-resistant facing to prevent surface erosion by airstream, complying with NFPA 90A or NFPA 90B. Treat natural-fiber products with antimicrobial coating.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acoustical Surfaces, Inc.
      b. Bonded Logic, Inc.
      c. Ductmate Industries, Inc.
   2. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested in accordance with ASTM C518.

3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with ASTM E84; certified by an NRTL.
4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

D. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick stainless steel; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) in diameter.

E. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpmor greater.
7. Secure liner with mechanical fasteners 4 inches (101.6 mm) from corners and at intervals not exceeding 12 inches (304.8 mm) transversely; at 3 inches (76.2 mm) from transverse joints and at intervals not exceeding 18 inches (457.2 mm) longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
   c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
   a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

4.08 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches (101.6 mm).
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10 inch (254 mm) wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 inch (254 mm) wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

4.09 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.

F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
   2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 EXECUTION

5.01 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch (25.4 mm), plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

J. Install fire, combination fire/smoke, and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.

K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. Comply with SMACNA's "IAQ Guidelines for Occupied

Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

M. Elbows: Use long-radius elbows wherever they fit.
   1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
   2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches (304.8 mm) and smaller and a minimum of five segments for 14 inches (355.6 mm) and larger.

N. Branch Connections: Use lateral or conical branch connections.

5.02 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

5.03 DUCTWORK EXPOSED TO WEATHER

A. All external joints are to have secure watertight mechanical connections. Seal all openings to provide weatherproof construction.

B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.

C. Single Wall:
   1. Ductwork shall be Type 304 stainless steel.
   2. Ductwork shall be galvanized steel.
      a. If duct outer surface is uninsulated, protect outer surface with suitable paint. Paint materials and application requirements are specified in Section 099113 "Exterior Painting."
   3. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section 230713 "Duct Insulation."

D. Double Wall:
   1. Ductwork shall comply with requirements in "Double-Wall Rectangular Ducts and Fittings" or "Double-Wall Round and Flat-Oval Ducts and Fittings" Article.
   2. Ductwork outer wall shall be Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.
   3. Provide interstitial insulation.

5.04 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
   1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   2. Outdoor, Supply-Air Ducts: Seal Class A.
   3. Outdoor, Exhaust Ducts: Seal Class C.
   4. Outdoor, Return-Air Ducts: Seal Class C.

5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

5.05 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (101.6 mm) thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (101.6 mm) thick.
   5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (609.6 mm) of each elbow and within 48 inches (1219.2 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (487.68 cm).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

5.06 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

5.07 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

5.08 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
   1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
   2. Test the following systems:
      a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
      b. Supply Ducts with a Pressure Class of 2- 3- 4- Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
      c. Return Ducts with a Pressure Class of 2- 3- 4- Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
      d. Exhaust Ducts with a Pressure Class of 2- 3- 4- Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
      e. Outdoor-Air Ducts with a Pressure Class of 2- 3- 4- Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
   3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
   5. Test for leaks before applying external insulation.
   6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
   7. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.
   2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
      a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

5.09 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. For cleaning of existing ductwork, see Section 230130.52 "Existing HVAC Air Distribution System Cleaning."

C. Use duct cleaning methodology as indicated in NADCA ACR.

D. Use service openings for entry and inspection.
   1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling to gain access during the cleaning process.

E. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

F. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

G. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

5.10 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

5.11 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
2. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior.

B. Supply Ducts:
1. Ducts Connected to Fan Coil Units, and Terminal Units:
a. Pressure Class: Positive 2-inch wg.

b. Minimum SMACNA Seal Class: C.
c. SMACNA Leakage Class for Rectangular: 16.
d. SMACNA Leakage Class for Round and Flat Oval: 8.

2. Ducts Connected to Constant-Volume Air-Handling Units:
   a. Pressure Class: Positive 3-inch wg.
   b. Minimum SMACNA Seal Class: B.
   c. SMACNA Leakage Class for Rectangular: 8.
   d. SMACNA Leakage Class for Round and Flat Oval: 4.
3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
   a. Pressure Class: Positive 4-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 4.
   d. SMACNA Leakage Class for Round and Flat Oval: 2.
4. Return Ducts:
5. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units Insert equipment:
   a. Pressure Class: Positive or negative 1-inch wg.
   b. Minimum SMACNA Seal Class: C.
   c. SMACNA Leakage Class for Rectangular: 16.
   d. SMACNA Leakage Class for Round and Flat Oval: 8.
6. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: B.
   c. SMACNA Leakage Class for Rectangular: 8.
   d. SMACNA Leakage Class for Round and Flat Oval: 4.
7. Exhaust Ducts:
8. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
   a. Pressure Class: Negative 1-inch wg.
   b. Minimum SMACNA Seal Class: C if negative pressure, and A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: 16.
   d. SMACNA Leakage Class for Round and Flat Oval: 8.
9. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: C if negative pressure, and B if positive pressure.
   c. SMACNA Leakage Class for Rectangular: 8.
   d. SMACNA Leakage Class for Round and Flat Oval: 4.
10. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
    a. Exposed to View: Type 304, stainless-steel sheet, No. 3 finish.
    b. Concealed: Type 304, stainless-steel sheet, No. 2D finish.
    c. Welded seams and joints.
    d. Pressure Class: Positive or negative 3-inch wg.
    e. Airtight/watertight.
11. Ducts Connected to Dishwashers, Dishwasher Hoods, and Other High-Humidity Locations:
    a. Type 304, stainless-steel sheet.
    b. Exposed to View: No. 3 finish.
    c. Concealed: No. 2D finish.
    d. Welded longitudinal seams; welded or flanged transverse joints with watertight EPDM gaskets.
    e. Pressure Class: Positive or negative 2-inch wg.
    f. Airtight/watertight.

12. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
13. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps:
    a. Pressure Class: Positive or negative 1-inch wg.
    b. Minimum SMACNA Seal Class: B.
    c. SMACNA Leakage Class for Rectangular: 8.
    d. SMACNA Leakage Class for Round and Flat Oval: 8.
14. Ducts Connected to Air-Handling Units :
    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: B.
    c. SMACNA Leakage Class for Rectangular: 8.
    d. SMACNA Leakage Class for Round and Flat Oval: 4.
15. Intermediate Reinforcement:
16. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
17. PVC-Coated Ducts:
    a. Exposed to Airstream: Match duct material.
    b. Not Exposed to Airstream: Match duct material.
18. Stainless-Steel Ducts:
    a. Exposed to Airstream: Match duct material.
    b. Not Exposed to Airstream: Match duct material.
19. Aluminum Ducts: galvanized steel coated with zinc chromate.

C. Liner:
    1. Transfer Ducts: Flexible elastomeric, 1-1/2 inch (38 mm)(es thick.

D. Double-Wall Duct Interstitial Insulation:
    1. Supply-Air Ducts: 2 inch (50.8 mm)(es thick.
    2. Return-Air Ducts: 2 inch (50.8 mm)(es thick.
    3. Exhaust-Air Ducts: 1h inch(es thick.

E. Elbow Configuration:
    1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
        a. Velocity 1000 fpm or Lower:
            1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
            2) Mitered Type RE 4 without vanes.
        b. Velocity 1000 to 1500 fpm:
            1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
            2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
            3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
        c. Velocity 1500 fpm or Higher:
            1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
            2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
            3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
    2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
        a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
        b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      4) Radius-to Diameter Ratio: 1.5.
   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

F. Branch Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
      a. Rectangular Main to Rectangular Branch: 45-degree entry.
      b. Rectangular Main to Round Branch: Conical spin in.
   2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
      a. Velocity 1000 fpm or Lower: 90-degree tap.
      b. Velocity 1000 to 1500 fpm: Conical tap.
      c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 233300
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.

B. AMCA 511 - Certified Ratings Program Product Rating Manual for Air Control Devices; 2021, with Editorial Revision (2022).

C. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2025b.

D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2027.

H. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2027.

I. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2027.

J. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

K. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.

L. UL 1978 - Grease Ducts; Current Edition, Including All Revisions.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. Section Includes:
   1. Backdraft and pressure relief dampers.
   2. Barometric relief dampers.
   3. Manual volume dampers.
   4. Control dampers.
   5. Fire dampers.
   6. Turning vanes.
   7. Duct-mounted access doors.
   8. Duct access panel assemblies.
   9. Flexible connectors.
   10. Duct security bars.
   11. Duct accessory hardware.

B. Related Requirements:
   1. Section 233346 "Flexible Ducts" for insulated and non-insulated flexible ducts.
   2. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
   3. Section 284621.13 "Conventional Fire-Alarm Systems" for duct-mounted fire and smoke detectors.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

B. Sustainable Design Submittals:

C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      b. Manual volume damper installations.
      c. Control-damper installations.
      d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
      e. Duct security bars.
      f. Include diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

B. Source quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 90A and NFPA 90B.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.02 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating; a Mestek Architectural Group company.
   2. Cesco Products; a division of MESTEK, Inc.
   3. Greenheck Fan Corporation.
   4. Lloyd Industries, Inc.
   5. Nailor Industries Inc.
   6. NCA Manufacturing, Inc.
   7. Pottorff.

8. Ruskin Company.
9. Safe Air - Dowco Products.
10. United Enertech.
11. Vent Products Co., Inc.

B. Description: Gravity balanced.

C. Performance:
1. Maximum Air Velocity: 1250 fpm.
2. Maximum System Pressure: 1 inch (25.4 mm) wg.
3. AMCA Certification: Test and rate in accordance with AMCA 511.]
4. Leakage:
a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
b. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
c. Class II: Leakage shall not exceed 10 cfm/sq. ft. against 1-inch wg differential static pressure.
d. Class III: Leakage shall not exceed 40 cfm/sq. ft. against 1-inch wg differential static pressure.

D. Construction:
1. Frame:
a. Hat shaped.
b. 0.093-inch-thick extruded aluminum Insert value and frame material type, with welded or mechanically attached corners and mounting flange.
2. Blades:
a. Multiple single-piece blades.
b. Center pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.
3. Blade Action: Parallel.

E. Blade Seals: Extruded vinyl, mechanically locked.

F. Blade Axles:
1. Material: Aluminum.
2. Diameter: 0.20 inch (5.08 mm).

G. Tie Bars and Brackets: Aluminum.

H. Return Spring: Adjustable tension.

I. Bearings: synthetic pivot bushings.

J. Damper Actuator - Electric:
1. Electric - 24 V ac.
2. UL 873 plenum rated.
3. Fully modulating.
a. Sufficient motor torqueto drive damper fully closed with adequate force to achieve required damper seal.
b. Minimum 90-degree drive rotation.
4. Clockwise or counterclockwise drive rotation as required for application.
5. Environmental Operating Range:
a. Temperature: Minus 40 to plus 130 deg F.
b. Humidity: 5 to 95 percent relative humidity noncondensing.
6. Environmental Enclosure: NEMA 2.
7. Actuator to be factory mounted and provided with a single-point wiring connection.

K. Controllers, Electrical Devices, and Wiring:

1. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Electrical Connection: 24 V, 60 Hz.

L. Accessories:
1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Chain pulls.
4. Screen Mounting:
   a. Front mounted in sleeve.
      1) Sleeve Thickness: 20 gauge minimum.
      2) Sleeve Length: 6 inches (152.4 mm) minimum.
5. Screen Material: Galvanized steel.
6. Screen Type: Bird.
7. 90-degree stops.

2.03 BAROMETRIC RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a Mestek Architectural Group company.
2. Cesco Products; a division of MESTEK, Inc.
3. Greenheck Fan Corporation.
4. Lloyd Industries, Inc.
5. Nailor Industries Inc.
6. NCA Manufacturing, Inc.
7. Pottorff.
8. Ruskin Company.
9. Safe Air - Dowco Products.
10. United Enertech.
11. Vent Products Co., Inc.

B. General Requirements:
1. Suitable for horizontal or vertical mounting.
2. Maximum Air Velocity: 1250 fpm.
3. Maximum System Pressure: 2 inches (50.8 mm) wg.

C. Construction:
1. Frame: Hat shaped, 0.093-inch-thick extruded aluminum, with welded corners or mechanically attached and mounting flange.
2. Blades:
   a. Multiple, 0.050-inch-thick aluminum sheet.
   b. Maximum Width: 6 inches (152.4 mm).
   c. Action: Parallel.
   d. Balance: Gravity.
   e. Eccentrically pivoted.
3. Blade Seals: Neoprene.
4. Blade Axles: Stainless steel.
5. Tie Bars and Brackets:
   a. Material: Aluminum.
   b. Rattle free with 90-degree stop.
6. Bearings: Synthetic.

D. Pressure Adjustment: Return spring or counter weight with adjustable tension.

E. Accessories:

1. Flange on intake.
2. Adjustment device to permit setting for varying differential static pressures.

2.04 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Air Balance; a division of MESTEK, Inc.
      b. Aire Technologies.
      c. American Warming and Ventilating; a Mestek Architectural Group company.
      d. Arrow United Industries.
      e. Cesco Products; a division of MESTEK, Inc.
      f. Greenheck Fan Corporation.
      g. Lloyd Industries, Inc.
      h. McGill AirFlow LLC.
      i. Nailor Industries Inc.
      j. Pottorff.
      k. Ruskin Company.
      l. Safe Air - Dowco Products.
      m. United Enertech.
      n. Vent Products Co., Inc.
   2. Performance:
      a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.
   3. Construction:
      a. Linkage out of airstream.
      b. Suitable for horizontal or vertical airflow applications.
   4. Frames:
      a. Hat-shaped, 16-gauge-thick, galvanized sheet steel.
      b. Mitered and welded corners.
      c. Flanges for attaching to walls and flangeless frames for installing in ducts.
   5. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Galvanized steel; 16 gauge thick.
   6. Blade Axles: Galvanized steel.
   7. Bearings:
      a. Oil-impregnated bronze.
      b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
   8. Tie Bars and Brackets: Galvanized steel.
   9. Locking device to hold damper blades in a fixed position without vibration.

B. Low-Leakage, Steel, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Air Balance; a division of MESTEK, Inc.
      b. American Warming and Ventilating; a Mestek Architectural Group company.
      c. Arrow United Industries.
      d. Cesco Products; a division of MESTEK, Inc.
      e. Greenheck Fan Corporation.
      f. Lloyd Industries, Inc.

g. McGill AirFlow LLC.
h. Nailor Industries Inc.
i. Pottorff.
j. Ruskin Company.
k. Safe Air - Dowco Products.
l. United Enertech.
m. Vent Products Co., Inc.

2. Performance:
   a. AMCA Certification: Test and rate in accordance with AMCA 511.
   b. Leakage:
      1) Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
      2) Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
      3) Class II: Leakage shall not exceed 10 cfm/sq. ft. against 1-inch wg differential static pressure.
3. Construction:
   a. Linkage: Out of airstream.
   b. Suitable for horizontal or vertical airflow applications.
4. Frames:
   a. Hat, U, or angle shaped.
   b. Thickness: 18-gauge stainless steel.
   c. Mitered and welded corners.
   d. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized, roll-formed steel; 16 gauge thick.
6. Blade Edging Seals:
   a. Closed-cell neoprene.
   b. Inflatable seal blade edging or replaceable rubber seals.
7. Blade Jamb Seals: Flexible metal compression type.
8. Blade Axles: Galvanized steel.
9. Bearings:
   a. Oil-impregnated stainless steel sleeve.
   b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
10. Tie Bars and Brackets: Galvanized steel.
11. Locking device to hold damper blades in a fixed position without vibration.

2.05 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating; a Mestek Architectural Group company.
   2. Arrow United Industries.
   3. Carnes Company.
   4. Cesco Products; a division of MESTEK, Inc.
   5. Greenheck Fan Corporation.
   6. Lloyd Industries, Inc.
   7. McGill AirFlow LLC.
   8. Metal Form Manufacturing, Inc.

9. Nailor Industries Inc.
10. NCA Manufacturing, Inc.
11. Pottorff.
12. Ruskin Company.
13. Safe Air - Dowco Products.
14. United Enertech.
15. Vent Products Co., Inc.
16. Young Regulator Company.

B. General Requirements:
1. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
2. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.

C. Performance:
1. AMCA Certification: Test and rate in accordance with AMCA 511.
2. Leakage:
   a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
   b. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
   c. Class II: Leakage shall not exceed 10 cfm/sq. ft. against 1-inch wg differential static pressure.
   d. Class III: Leakage shall not exceed 40 cfm/sq. ft. against 1-inch wg differential static pressure.
3. Pressure Drop: 0.05 inch (1.27 mm) wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
4. Velocity: Up to 3000 fpm.
5. Temperature: Minus 25 to plus 180 deg F.
6. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

D. Construction:
1. Linkage out of airstream.
2. Suitable for horizontal or vertical airflow applications.
3. Frames:
   a. Hat, U, or angle shaped.
   b. 16-gauge-thick, galvanized sheet steel.
   c. Interlocking, gusseted corners.
   d. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
   a. Multiple blade with maximum blade width of 8 inches (203.2 mm).
   b. Opposed-blade design.
   c. Aluminum.
   d. 16-gauge-thick single skin or 14-gauge-thick air foil dual skin.
5. Blade Edging Seals:
   a. Replaceable PVC.
   b. Inflatable seal blade edging, or replaceable rubber seals.
6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch diameter; stainless steel.
8. Blade-Linkage Hardware: Zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of air stream.

9. Bearings:
    a. Oil-impregnated stainless steel sleeve.
    b. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.

E. Damper Actuator - Electric:
1. Electric - 24 V ac.
2. UL 873, plenum rated.
3. Fully modulating.
    a. Sufficient motor torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
    b. Minimum 90-degree drive rotation.
4. Clockwise or counterclockwise drive rotation as required for application.
5. Environmental Operating Range:
    a. Temperature: Minus 40 to plus 130 deg F.
    b. Humidity: 5 to 95 percent relative humidity noncondensing.
6. Environmental enclosure: NEMA 2.
7. Actuator to be factory mounted and provided with a single-point wiring connection.

F. Controllers, Electrical Devices, and Wiring:
1. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Electrical Connection: 24 V, 60 Hz.

2.06 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance; a division of MESTEK, Inc.
2. Aire Technologies.
3. Arrow United Industries.
4. Cesco Products; a division of MESTEK, Inc.
5. CL WARD & Family Inc.
6. Greenheck Fan Corporation.
7. NCA Manufacturing, Inc.
8. Pottorff.
9. Prefco.
10. Ruskin Company.
11. Safe Air - Dowco Products.
12. United Enertech.
13. Vent Products Co., Inc.

B. Type: Static and dynamic; rated and labeled in accordance with UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000 fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.

F. Mounting Sleeve: Factory- or field-installed, stainless steel; gauge in accordance with UL listing.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed stainless steel,. Material gauge is to be in accordance with UL listing.

I. Horizontal Dampers: Include blade lock and stainless steel closure spring.

J. Heat-Responsive Device:

1. Replaceable, 165 deg F rated, fusible links.
2. Electric, replaceable link and switch package, factory installed, 165 deg F rated.

2.07 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aero-Dyne Sound Control Co.
   2. CL WARD & Family Inc.
   3. Ductmate Industries, Inc.
   4. Duro Dyne Inc.
   5. DynAir; a Carlisle Company.
   6. Elgen Manufacturing.
   7. Ward Industries; a brand of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
   1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

E. Vane Construction:
   1. Single wall.
   2. Single wall for ducts up to 48 inches (1219.2 mm) wide and double wall for larger dimensions.

2.08 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aire Technologies.
   2. Arrow United Industries.
   3. Cesco Products; a division of MESTEK, Inc.
   4. CL WARD & Family Inc.
   5. Ductmate Industries, Inc.
   6. Duro Dyne Inc.
   7. Elgen Manufacturing.
   8. Flexmaster U.S.A., Inc.
   9. McGill AirFlow LLC.
   10. Ruskin Company.
   11. United Enertech.
   12. Ventfabrics, Inc.
   13. Ward Industries; a brand of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."
   1. Door:
      a. Double wall, rectangular.

b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. 0.032-inch thick aluminum or24-gauge-thick stainless steel door panel.
d. Vision panel.
e. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
f. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   a. 24-gauge-thick galvanized steel or 0.032-inch-thick aluminum frame.
3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Continuousand two compression latches with outside and inside handles.
   d. Access Doors Larger Than 24 by 48 Inches: Continuousand two compression latches with outside and inside handles.

C. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
   a. 0.032?inch-thick aluminum or24-gauge-thick stainless steel door panel.
2. Door: Single wall with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 3.0 to 8.0 inches (203.2 mm) wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.09 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Flame Gard, Inc.

B. Access panels used in cooking applications:
1. Labeled compliant to NFPA 96 for grease duct access doors.
2. Labeled in accordance with UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 16-gauge stainless steel.

D. Fasteners: Stainlesssteel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96, grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10 inches (254 mm) wg positive or negative.

2.10 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Duro Dyne Inc.
4. DynAir; a Carlisle Company.
5. Elgen Manufacturing.

6. Ventfabrics, Inc.
7. Ward Industries; a brand of Hart & Cooley, Inc.

B. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Materials: Flame-retardant or noncombustible fabrics.

E. Coatings and Adhesives: Comply with UL 181, Class 1.

F. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches (146 mm) wide attached to two strips of 2-3/4-inch-wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

G. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

H. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

I. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
1. Minimum Weight: 16 oz./sq. yd..
2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F.

J. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
1. Minimum Weight: 14 oz./sq. yd..
2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F.

K. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.
8. DUCT ACCESSORY HARDWARE

L. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.

3. Duro Dyne Inc.
4. DynAir; a Carlisle Company.
5. Elgen Manufacturing.
6. Hardcast; a Carlisle Company.
7. United Enertech.
8. Ventfabrics, Inc.
9. Ward Industries; a brand of Hart & Cooley, Inc.

M. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

N. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.11 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches (914.4 mm) or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.

E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

F. Set dampers to fully open position before testing, adjusting, and balancing.

G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

H. Install fire dampers in accordance with UL listing.

I. Duct security bars:
   1. Construct duct security bars from 0.164-inch steel sleeve, continuously welded at all joints, and 1/2-inch- diameter steel bars, 6 inches (152.4 mm) o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2-1/2-by-2-1/2-by-1/4-inch steel angle to four sides and both ends of sleeve.
   2. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch hinged access panel with cam lock in duct in each side of sleeve.
   3. Secure duct security bar assembly to building structure as indicated in manufacturer's installation instructions.

J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream and downstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   7. At each change in direction and at maximum 50-ft. spacing.
   8. Upstream and downstream from turning vanes.
   9. Upstream or downstream from duct silencers.
   10. For grease ducts, install at locations and spacing as required by NFPA 96.
   11. Control devices requiring inspection.
   12. Elsewhere as indicated.

K. Install access doors with swing against duct static pressure.

L. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches (127 mm).
   2. Two-Hand Access: 12 by 6 inches (152.4 mm).
   3. Head and Hand Access: 18 by 10 inches (254 mm).
   4. Head and Shoulders Access: 21 by 14 inches (355.6 mm).
   5. Body Access: 25 by 14 inches (355.6 mm).
   6. Body plus Ladder Access: 25 by 17 inches (431.8 mm).

M. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

N. Install flexible connectors to connect ducts to equipment.

O. For fans developing static pressures of 5 inches (127 mm) wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

P. Install duct test holes where required for testing and balancing purposes.

Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.02 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 233346
FLEXIBLE DUCTS

SECTION 23 33 46

FLEXIBLE DUCTS

PART 1 GENERAL

3.01 REFERENCE STANDARDS

A. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.

B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2027.

C. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2027.

D. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

3.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

3.03 SUMMARY

A. Section Includes:
   1. Non-insulated flexible ducts.
   2. Insulated flexible ducts.

3.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:
   1. Shop Drawings: For flexible ducts.
   2. Include plans showing locations and mounting and attachment details.

3.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

PART 2 PRODUCTS

4.01 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."

D. Comply with ASTM E96/E96M, "Test Methods for Water Vapor Transmission of Materials."

4.02 NON-INSULATED FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flexmaster U.S.A., Inc.
   2. JP Lamborn Co.

3. McGill AirFlow LLC.
4. Thermaflex; a Flex-Tek Group company.
5. Ward Industries; a brand of Hart & Cooley, Inc.

B. Non-Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.

C. Non-Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.
1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.

D. Non-Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.

E. Non-Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.

F. Non-Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil.
1. Pressure Rating: 8-inch wg positive or negative.
2. Maximum Air Velocity: 5000 fpm.
3. Temperature Range: Minus 100 to plus 435 deg F.

4.03 INSULATED FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flexmaster U.S.A., Inc.
2. JP Lamborn Co.
3. McGill AirFlow LLC.
4. Thermaflex; a Flex-Tek Group company.
5. Ward Industries; a brand of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1 R6.

C. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminizedvapor-barrier film.
1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1 R6.

D. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminizedvapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1 R6 *{font-family:"Arial";font-size:10pt;}img{max-width:300px;max-height:300px;width:225px;height:225px;}span {white-space:pre; }

E. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminizedvapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1 R6.

F. Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil; fibrous-glass insulation; aluminizedvapor-barrier film.
1. Pressure Rating: 8-inch wg positive or negative.
2. Maximum Air Velocity: 5000 fpm.
3. Temperature Range: Minus 20 to plus 250 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1 R6.

4.04 FLEXIBLE DUCT CONNECTORS

A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches (457.2 mm), to suit duct size.

B. Non-Clamp Connectors: Adhesive plus sheet metal screws.

PART 3 EXECUTION

5.01 INSTALLATION

A. Install flexible ducts according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.

C. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

D. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

E. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

F. Install duct test holes where required for testing and balancing purposes.

G. Installation:
1. Install ducts fully extended.
2. Do not bend ducts across sharp corners.
3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns.

H. Supporting Flexible Ducts:
1. Suspend flexible ducts with bands 1-1/2 inches (38 mm) wide or wider and spaced a maximum of 48 inches (1219.2 mm) apart. Maximum centerline sag between supports shall not exceed 1/2 inch (12.7 mm) per 12 inches (304.8 mm).
2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.

3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches (1828.8 mm) o.c.

END OF SECTION

SECTION 233423
HVAC POWER VENTILATORS

SECTION 23 34 23

HVAC POWER VENTILATORS

PART 1 GENERAL

3.01 REFERENCE STANDARDS

A. AMCA 99 - Standards Handbook; 2025.

B. AMCA 211 - Certified Ratings Program — Product Rating Manual for Fan and Air Moving Product Air Performance Ratings; 2026.

C. AMCA 311 - Certified Ratings Program Product Rating Manual for Fan Sound Performance; 2016.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2027.

G. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2027.

H. UL 705 - Power Ventilators; Current Edition, Including All Revisions.

I. UL 762 - Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances; Current Edition, Including All Revisions.

3.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

3.03 SUMMARY

A. Section Includes:
   1. Axial roof ventilators.
   2. Ceiling-mounted ventilators.
   3. Centrifugal ventilators - roof downblast.
   4. Centrifugal ventilators - roof upblast and sidewall.
   5. Sidewall propeller fans.

3.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
   2. Rated capacities, operating characteristics, and furnished specialties and accessories.
   3. Certified fan performance curves with system operating conditions indicated.
   4. Certified fan sound-power ratings.
   5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   6. Material thickness and finishes, including color charts.
   7. Dampers, including housings, linkages, and operators.
   8. Prefabricated roof curbs.
   9. Fan speed controllers.

B. Shop Drawings:
   1. Include plans, elevations, sections, and attachment details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators.

C. Delegated Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

3.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: Submit certificates that specified equipment will withstand required wind forces, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

3.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

3.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Belts: One set(s) for each belt-driven unit.

PART 2 PRODUCTS

4.01 PERFORMANCE REQUIREMENTS

A. Unusual Service Conditions
1. Base fan-performance ratings per ASHRAE fundamentals mean climatic design conditions for project location.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation, supports,, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

G. Seismic Performance: HVAC power ventilators shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. See Section 230548 "Vibration and Seismic Controls for HVAC."
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   2. Component Importance Factor: 1.5.

H. Wind Performance: Air-handling units shall withstand the effects of wind determined in accordance with to ASCE/SEI 7. See Section 230548.13 "Vibration Controls for HVAC."

4.02 AXIAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Manufacturing Corp.
   2. Aerovent; a division of Twin City Fan Companies, Ltd.
   3. Airmaster Fan Company.
   4. American Coolair Corporation.
   5. FloAire National.
   6. Greenheck Fan Corporation.
   7. Hartzell Fan Incorporated.
   8. JencoFan.
   9. Loren Cook Company.
   10. Moffitt Corporation Inc.
   11. New York Blower Company (The).
   12. PennBarry.
   13. Quietaire Inc.
   14. Rupp Air Management Systems.
   15. S & P USA Ventilation Systems, LLC.

B. Housing: Heavy-gauge, removable, spun-aluminum dome top and outlet baffle; square, one-piece, hinged, aluminum base.

C. Fan Wheel: Aluminum hub and blades. Spark-resistant construction classified in accordance with AMCA 99, Section 8, Type B.

D. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.

E. Accessories:
   1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
   2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
5. Stack hood with built-in backdraft dampers.
6. Extended lubrication lines.

F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 12 inches (304.8 mm).
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: 1/2-inch- thick steel bars welded in place to form 6-inch squares.
7. Mounting Pedestal: Galvanized steel with removable access panel.

4.03 CEILING-MOUNTED VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Engineering & Manufacturing Corp.
2. American Coolair Corporation.
3. Broan-NuTone LLC.
4. Carnes Company.
5. FloAire National.
6. Greenheck Fan Corporation.
7. JencoFan.
8. Loren Cook Company.
9. PennBarry.
10. S & P USA Ventilation Systems, LLC.

B. Housing: Steel, lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel removable for service.

D. Back-draft damper: Integral.

E. Grille: Aluminum, louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories:
1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless steel springs, and fusible link.
6. Filter: Washable aluminum to fit between fan and grille.
7. Isolation: Rubber-in-shear vibration isolators.
8. Manufacturer's standard roof jack or wall cap, and transition fittings.

4.04 CENTRIFUGAL VENTILATORS - ROOF DOWNBLAST

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Manufacturing Corp.
   2. Aerovent; a division of Twin City Fan Companies, Ltd.
   3. Airmaster Fan Company.
   4. American Coolair Corporation.
   5. Carnes Company.
   6. FloAire National.
   7. Greenheck Fan Corporation.
   8. JencoFan.
   9. Loren Cook Company.
   10. New York Blower Company (The).
   11. Northern Blower, Inc.
   12. PennBarry.
   13. Quietaire Inc.
   14. Rupp Air Management Systems.
   15. S & P USA Ventilation Systems, LLC.

B. Housing: Downblast; removable extruded-aluminum rectangular top; square, one-piece aluminum base with venturi inlet cone.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades Type B.

D. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
   6. Fan and motor isolated from exhaust airstream.

E. Accessories:
   1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
   3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
   5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
   6. Spark-resistant, all-aluminum wheel construction.
   7. Mounting Pedestal: Galvanized steel with removable access panel.

F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
   1. Configuration: Self-flashing without a cant strip, with mounting flange.
   2. Overall Height: 12 inches (304.8 mm).
   3. Sound Curb: Curb with sound-absorbing insulation.
   4. Hinged sub-base to provide access to damper or as cleanout for grease applications.

5. Burglar Bars: 1/2-inch- thick steel bars welded in place to form 6-inch squares.
6. Pitch Mounting: Manufacture curb for roof slope.
7. Metal Liner: Galvanized steel.
8. Mounting Pedestal: Galvanized steel with removable access panel.

4.05 CENTRIFUGAL VENTILATORS - ROOF UPBLAST OR SIDEWALL

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Manufacturing Corp.
   2. Aerovent; a division of Twin City Fan Companies, Ltd.
   3. Airmaster Fan Company.
   4. American Coolair Corporation.
   5. Carnes Company.
   6. FloAire National.
   7. Greenheck Fan Corporation.
   8. JencoFan.
   9. Loren Cook Company.
   10. New York Blower Company (The).
   11. PennBarry.
   12. Quietaire Inc.
   13. Rupp Air Management Systems.
   14. S & P USA Ventilation Systems, LLC.

B. Configuration: Centrifugal roof upblast roof upblast, grease hood kitchen sidewall ventilator.

C. Housing: Removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.
   1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
   2. Provide grease collector.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades; spark-resistant construction classified in accordance with AMCA 99, Section 8, Type B.

E. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA9, L(10) of 100,000 hours.
   4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
   6. Fan and motor isolated from exhaust airstream.

F. Accessories:
   1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
   3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
   5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

6. Spark-resistant, all-aluminum wheel construction.
7. Mounting Pedestal: Galvanized steel with removable access panel.
8. Wall Mount Adapter: Attach wall-mounted fan to wall.
9. Restaurant Kitchen Exhaust: UL 762 listed for grease-laden air exhaust.

G. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
   1. Configuration: Manufactured to accommodate roof slope.

H. Prefabricated Kitchen Exhaust Roof Curbs: Galvanized steel; mitered and welded corners; ventilation openings on all sides to ventilate curb interstitial space. Size as required to suit roof opening and fan base.
   1. Configuration: manufactured to accommodate roof slope.
   2. Overall Height: 12 inches (304.8 mm).
   3. Sound Curb: Curb with sound-absorbing insulation.
   4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
   5. Burglar Bars: 1/2-inch- thick steel bars welded in place to form 6-inch squares.
   6. Pitch Mounting: Manufacture curb for roof slope.
   7. Metal Liner: Galvanized steel.
   8. Mounting Pedestal: Galvanized steel with removable access panel.
   9. Vented Curb: For kitchen exhaust; 12-inch-high galvanized steel; unlined, with louvered vents in vertical sides.
   10. NFPA 96 code requirements for commercial cooking operations.
   11. Kitchen Hood Exhaust: UL 762 listed for grease-laden air.

4.06 SIDEWALL PROPELLER FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Manufacturing Corp.
   2. Aerovent; a division of Twin City Fan Companies, Ltd.
   3. Airmaster Fan Company.
   4. American Coolair Corporation.
   5. Carnes Company.
   6. JencoFan.
   7. Loren Cook Company.
   8. Moffitt Corporation Inc.
   9. Peerless Blowers.
   10. PennBarry.
   11. Quietaire Inc.

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring, with baked-enamel finish coat applied after assembly.

C. Fan Wheels: Formed-steel blades riveted to heavy-gauge steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Fan Drive, Direct: Direct-drive motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

F. Fan Drive, Belt:
   1. Belt drive.
   2. Resiliently mounted to housing.
   3. Statically and dynamically balanced.

4. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
5. Extend grease fitting to accessible location outside of unit.
6. Service Factor Based on Fan Motor Size: 1.4.
7. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
8. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   a. Ball-Bearing Rating Life: ABMA 9, L(10) of 100,000 hours.
9. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
10. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
11. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
12. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

G. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Dampers: Counterbalanced, parallel-blade, backdraft dampers factory set to close when fan stops.
3. Motorized Dampers: Parallel-blade dampers with electric actuator wired to close when fan stops.
4. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
5. Wall Sleeve: Galvanized steel to match fan and accessory size.
6. Weathershield Hood: Galvanized steel to match fan and accessory size.
7. Weathershield Front Guard: Galvanized steel with expanded metal screen.

4.07 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

4.08 SOURCE QUALITY CONTROL

A. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.

B. AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.

C. AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.

D. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 3 EXECUTION

5.01 INSTALLATION, GENERAL

A. Install power ventilators level and plumb.

B. Equipment Mounting:
1. Secure roof-mounted fans to roof curbs with zinc-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.
2. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
3. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

5.02 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

5.03 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
   1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
   2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (12.7 mm) high.

5.04 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

5.05 STARTUP SERVICE:

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks in accordance with manufacturer's written instructions.
   2. Verify that shipping, blocking, and bracing are removed.
   3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   4. Verify that cleaning and adjusting are complete.
   5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
   6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   7. Adjust belt tension.
   8. Adjust damper linkages for proper damper operation.
   9. Verify lubrication for bearings and other moving parts.
   10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   12. Shut unit down and reconnect automatic temperature-control operators.
   13. Remove and replace malfunctioning units and retest as specified above.

5.06 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

5.07 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

5.08 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.
   1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Test and adjust controls and safeties.
   3. Fans and components will be considered defective if they do not pass tests and inspections.
   4. Prepare test and inspection reports.

5.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION

SECTION 233713
AIR DIFFUSERS

SECTION 23 37 13

AIR DIFFUSERS

PART 1 GENERAL

3.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

3.02 SUMMARY

A. Section Includes:
   1. Round ceiling diffusers.
   2. Rectangular and square ceiling diffusers.
   3. Louver face diffusers.
   4. Linear bar diffusers.
   5. Linear slot diffusers.
   6. High-capacity drum louver diffusers.

B. Related Requirements:
   1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.
   2. Section 233713.23 "Air Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.
   3. Section 233713.43 "Security Registers and Grilles" for security registers and security grilles.
   4. Section 233716 "Fabric Air-Diffusion Devices" for continuous tubular diffusers.

3.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified. Actual size of smallest diffuser indicated.

C. Samples for Initial Selection: For diffusers with factory-applied color finishes. Actual size of smallest diffuser indicated.

D. Samples for Verification: For diffusers, in manufacturer's standard sizes to verify color selected. Actual size of smallest diffuser indicated.

3.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
   5. Duct access panels.

B. Source quality-control reports.

PART 2 PRODUCTS

4.01 ROUND CEILING DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. METALAIRE, Inc.
   2. Nailor Industries Inc.
   3. Price Industries.
   4. Titus, a division of Air System Components; Johnson Controls, Inc.
   5. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material: Aluminum.

D. Finish: Baked enamel, color selected by Architect.

E. Face Style: Four cone.

F. Mounting: Duct connection.

G. Pattern: Fully adjustable.

H. Dampers: Butterfly.

I. Accessories:
   1. Equalizing grid.
   2. Plaster ring.
   3. Safety chain.
   4. Wire guard.
   5. Sectorizing baffles.
   6. Operating rod extension.

4.02 RECTANGULAR AND SQUARE CEILING DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
   2. METALAIRE, Inc.
   3. Nailor Industries Inc.
   4. Price Industries.
   5. Titus, a division of Air System Components; Johnson Controls, Inc.
   6. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material: Aluminum.

D. Finish: Baked enamel, color selected by Architect.

E. Face Size: 24 by 24 inches (609.6 mm) Insert dimensions.

F. Face Style: Four cone.

G. Mounting: Lay in or Surface.

H. Pattern: Fixed Adjustable.

I. Dampers: Radial opposed blade.

J. Accessories:
   1. Equalizing grid.
   2. Plaster ring.
   3. Safety chain.
   4. Wire guard.

5. Sectorizing baffles.
6. Operating rod extension.

4.03 LOUVER FACE DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. METALAIRE, Inc.
   2. Nailor Industries Inc.
   3. Price Industries.
   4. Shoemaker Mfg. Co.
   5. Titus, a division of Air System Components; Johnson Controls, Inc
B. Devices shall be specifically designed for variable-air-volume flows.
C. Material: Aluminum.
D. Finish: Baked enamel, color selected by Architect.
E. Face Size: Refer to Drawings.
F. Mounting: Lay-in Surface.
G. Pattern: Adjustable core style.
H. Dampers: Radial opposed blade.
I. Accessories:
   1. Square to round neck adaptor.
   2. Adjustable pattern vanes.
   3. Throw reducing vanes.
   4. Equalizing grid.
   5. Plaster ring.
   6. Safety chain.
   7. Wire guard.
   8. Sectorizing baffles.
   9. Operating rod extension.

4.04 LINEAR BAR DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
   2. METALAIRE, Inc.
   3. Nailor Industries Inc.
   4. Price Industries.
   5. Titus, a division of Air System Components; Johnson Controls, Inc.
B. Devices shall be specifically designed for variable-air-volume flows.
C. Material: Aluminum.
D. Finish: Baked enamel, color selected by Architect.
E. Narrow Core Spacing Arrangement: 1/8-inch-thick blades spaced 1/4 inch (6.35 mm) apart; 15-degree deflection.
F. Wide Core Spacing Arrangement: 1/8-inch-thick blades spaced 1/2 inch (12.7 mm) apart; 15-degree deflection.
G. Wide Core Spacing Arrangement: 3/16-inch-thick blades spaced 1/2 inch (12.7 mm) apart; 30-degree deflection.
H. Pencil-Proof Core Spacing Arrangement: 3/16-inch-thick blades spaced 7/16 inch (11.11 mm) apart; 30-degree deflection.

I. Two-Way Deflection Vanes: Extruded construction fixedadjustablelouvers with removable core.

J. Frame: 1 inch (25.4 mm) wide.

K. Mounting Frame: Filter.

L. Mounting: Concealed bracket.

M. Damper Type: Adjustable opposed-blade assembly.

N. Accessories: Directional vanes Alignment pins Core clips Blank-off strips.

4.05 LINEAR SLOT DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
   2. METALAIRE, Inc.
   3. Nailor Industries Inc.
   4. Price Industries.
   5. Titus, a division of Air System Components; Johnson Controls, Inc.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material - Shell: Aluminum, insulated.

D. Material - Pattern Controller and Tees: Aluminum.

E. Finish - Face and Shell: Baked enamel, black (coordinate with architect).

F. Finish - Pattern Controller: Baked enamel, black.(coordinate with architect).

G. Finish - Tees: Baked enamel, color selected by Architect.

H. Slot Width: Refer to plans.

I. Number of Slots: Refer to Plans

J. Length: Refer to Plans

K. Accessories: T-bar slot Center notch T-bar on inlet side T-bar on both sides T-bar clip on one side T-bar clips on both sides.
   a. 3.0 EXECUTION

4.06 EXAMINATION

A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

4.07 INSTALLATION

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

4.08 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 237433
PACKAGED DX VAV ROOFTOP UNITS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2026.

B. ASTM D1929 - Standard Test Method for Determining Ignition Temperature of Plastics; 2023.

C. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 GENERAL DESCRIPTION

A. This section includes the design, controls and installation requirements for packaged rooftop units / outdoor air handling units.

B. This Section includes cooling and heating rooftop Variable Volume Packaged DX air conditioning units.

1.04 QUALITY ASSURANCE

A. Provide units and roof curbs rated for project wind loads in accordance with IBC requirements. Reference structural design documents for design wind load conditions.

B. Packaged air-cooled condenser units shall be certified in accordance with ANSI/AHRI Standard 340/360 performance rating of commercial and industrial unitary air-conditioning and heat pump equipment.

C. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

D. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.

E. Unit Energy Efficiency Ratio (EER) shall be equal to or greater than prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

F. Comply with the requirements of International Energy Conservation Code.

G. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

1.05 SUBMITTALS

A. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, control equipment and sequences, electrical characteristics, and connection requirements

B. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances, and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. A wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring. Include shop drawings of proposed roof curbs. Include mounting Details for securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system. Include wiring Diagrams indicating power, signal, and control connections.

C. Manufacturer’s Warranty Certificate

D. Operations & Maintenance Manuals

1.06 DELIVERY, STORAGE, AND HANDLING

A. Units shall be shipped with doors screwed shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.

B. Follow Installation, Operation, and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.

C. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation, and Maintenance manual.

D. Coordinate size, location, and installation of rooftop replacement-air unit manufacturer's roof curbs and equipment support with roof Installer

1.07 WARRANTY

A. Warrant unit for a period of 12 months from the date of equipment startup. The warranty shall cover defective material and workmanship within the specified warranty period. The warranty excludes parts associated with routine maintenance, such as belts and filters.

B. Provide manufacturer’s 5-year compressor parts only warranty.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Products shall be provided by the following manufacturers:
   1. AAON
   2. Carrier
   3. Trane
   4. Daikin
   5. Substitute equipment must be pre-approved prior to bidding and award of contract.

2.02 ROOFTOP UNITS

A. General Description
   1. Packaged rooftop units shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, and unit controls.
   2. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. The run test report shall be supplied with the unit in the service compartment’s literature pocket.
   3. Units shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
   4. Unit components shall be labeled, including refrigeration system components, and electrical and controls components.
   5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
   6. Installation, Operation, and Maintenance manuals shall be supplied within the unit.
   7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment’s hinged access door.
   8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment’s hinged access door.
   9. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include final balancing of the supply fan assemblies, a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
   10. Units shall be specifically designed for outdoor rooftop applications and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with refrigerant and oil.

B. Construction
   1. Unit casing and roof shall be double wall construction with foam injected rigid polyurethane insulation. Interior and exterior panels shall be fabricated from G90

galvanized steel. Provide double wall construction with a thermal break to prevent exterior condensation. Provide unit with lifting lugs and knockouts for electrical and piping connections. Inside panels surfaces shall be cleanable.

2. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
3. Exterior Finish: Baked-enamel paint finishes including a base primer and high quality, polyester resin topcoat of factory standard color. Finished panel surfaces shall withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.
4. Provide units designed for 8 inches (203.2 mm) positive or negative static pressure. Unit casing leakage shall not exceed AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% at design static pressure. Deflection shall be measured at the midpoint of the panel height and width. Provide units with continuous sealing between panels, access doors and openings. Piping and electrical conduits through cabinet panels shall include sealing to reduce air leakage.
5. Slope unit roof to provide complete drainage. Provide access doors with drip ledges.
6. Provide units with hinged access doors for compartments containing filters, dampers, cooling coils, compressors, electrical, and controls components. Provide access doors with quarter turn, zinc cast latch handles. Provide access doors with full-length stainless-steel piano hinges.
7. Provide units with base discharge and return air openings with upturned flanges at least 1/2 inch (12.7 mm) in height around the opening.

C. Electrical
1. Provide units factory pre-wired for single point power connection and unit mounted non-fused disconnect switch in NEMA 4 enclosure.
2. Provide units with factory pre-wired 115V, 15-amp GFI service outlet in the unit control panel.
3. Provide units with factory pre-wired control voltage power supplies.
4. Provide units with voltage / phase protection modules interlocked to shut down unit under fault condition.
5. Provide units with factory pre-wired variable frequency fan motor drives mounted within the unit.

D. Supply Fans
1. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.
2. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service life with external lubrication points.
4. Provide premium efficiency, inverter duty fan motors.

E. Dampers
1. Provide units with AMCA 500 compliant low leakage outside air dampers suitable for field installed motorized actuators. Dampers shall be aluminum blade and frame with stainless steel shafts and side jam seals, resilient blade tip seals, and low friction shaft bearings.
2. Provide units with barometric relief dampers.
3. Provide inlet and outlet dampers with factory installed weather hoods and bird screen.

F. Cooling Coils
1. Evaporator Coils
   a. Coils shall be copper tube with aluminum fins mechanically bonded to the tubes mounted in stainless steel casings.
   b. Multi-stage coils shall be intertwined without face or row splits.
   c. Design, test, fabricate, and rate coils according to ARI 410 and ASHRAE 33. Coils shall be leak tested to minimum 300 psig (2068.43 kPa).

d. Furnish coils with circuited distributors.

2. Provide coils with ASHRAE 62.1 compliant stainless steel drain pans. Positively sloped drain pan shall be provided with pans sloped in two directions minimum 1/8" per foot. Extend drain pans below headers and beyond the leaving side of the coil in accordance with ASHRAE requirements. The drain pan construction shall be of a stainless-steel design. Provide threaded drain connection extending through the unit base. Insulate drain pans per ASHRAE requirements.

G. Refrigeration System
1. Provide units with factory charged refrigerant.
2. Compressors shall be variable capacity scroll type with thermal overload protection.
3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation.
4. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
5. Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control valve.
6. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low-pressure sides and a factory installed liquid line filter driers.
7. Units shall include factory provided and compressor sound jackets installed on all compressors.
8. Each refrigeration circuit shall be provided with an adjustable temperature sensor freeze stat which shuts down the cooling circuits when the evaporator coil tubing falls below the setpoint.
9. Capacity Control: 10% to 100 percent modulating capacity control using variable capacity compressors and/or hot-gas bypass (if necessary).
10. Provide units with low ambient temperature control valves.

H. Condensers
1. Provide fin tube condenser coils with copper tubes and aluminum fins.
2. Design, test, fabricate, and rate coils according to ARI 410 and ASHRAE 33 for minimum of 10°F of refrigerant sub-cooling. Coils shall be leak tested to minimum 300 psig (2068.43 kPa).
3. Condenser fans shall be vertical discharge, axial flow, direct drive fans with high efficiency electrically commutated motors and factory installed head pressure control module. Condenser airflow should continuously modulate based on head pressure and cooling operation shall be allowed down to 15°F with adjustable compressor lockout.
4. Provide units with corrosion resistant hail guards.

I. Electric-Resistance Heating Coils
1. Comply with UL 1995
2. Open Heating Elements: Resistance wire of 80% nickel and 20% chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to support brackets and mounted in a galvanized steel frame.
3. Overtemperature Protection: Disk type, automatic resetting thermal cutout safety switch serviceable through terminal box without requiring coil removal.
4. Secondary Protection: Load carrying manual reset thermal cutout switch factory wired in series with each heating element.
5. Airflow Sensor: Provide heating coil assemblies with airflow proving switch interlocked to prevent engagement on failure of adequate airflow.
6. Capacity Controls: Modulating silicone-controlled rectifier (SCR) based or pulse width modulating based controllers with remote 4-20 mA or 0-10 V input signal.

J. Filters

1. Units shall include 2-inch thick, pleated panel filters with an ASHRAE MERV rating of 13, upstream of the cooling coil.
2. Provide units with a Magnehelic differential pressure gauge and sensor tubing mounted in the controls compartment to indicate filter pressure drop.

K. Controls
1. Provide units with factory installed and pre-wired controls. Including factory installed and remote mounted sensors and field devices.
2. Unit controllers shall be digital microprocessor type for control of all features and options on the unit. The controller shall be factory installed in the unit controls compartment and factory tested. Controller shall be capable of standalone operation with unit configuration with setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
3. The controller should have an onboard clock and calendar functions that allow for occupancy scheduling.
4. The controller should have an onboard clock and calendar functions that allow for occupancy scheduling.
5. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
6. Variable Air Volume Control: Modulate variable speed supply fan to maintain remote S/A static pressure about adjustable setpoint.
7. Variable Capacity Control: Modulate cooling capacity to maintain S/A temperature about adjustable cooling setpoint. Modulate heating capacity to maintain S/A temp about adjustable heating setpoint.
8. Provide units with high condensate level switch interlocked to shut down the unit when a high-water level is detected in the drain pan.
9. Provide units with anti-short cycle timing and time delay between compressors to provide a higher level of machine protection.
10. Provide controllers with ASHRAE 135 compliant BACNet communications interface.

L. Curbs: Provide insulated structural roof curbs, minimum 14” high or as indicated, fabricated from galvanized steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Examine rough-in for unit to verify actual locations of piping and duct connections before equipment installation.

B. Install equipment in accordance with manufacturer’s installation manual instructions.

C. Install and secure roof curb to roof with concrete anchor bolts or as indicated. Coordinate curb installation with roof installation.

D. Secure unit to roof curb with resilient gasket or sealant in accordance with manufacturer’s instructions.

E. Connect ductwork, condensate piping, electrical, controls, and fire alarm raceways and cabling as required. Route all connections through roof curb unless indicated otherwise.

F. Provide condensate traps and route discharge to nearest sanitary drain or as indicated.

G. Connect ductwork with flexible connections or as indicated.

H. Connect electrical service in accordance with Division 26 requirements. Ground and bond equipment in accordance with Division 26 requirements.

I. Engage a factory-authorized service representative to perform startup service. Configure unit for indicated sequences and operation and as required. Inspect and test unit in accordance with manufacturer's instructions. Remove internal shipping bolts, blocks, and tie-downs as required. Start-up and test units per manufacturer's instructions. Adjust setpoints, programming, scheduling, and safeties. Submit written start-up report for review. Commission and demonstrate unit operation under direction of Owner's commissioning authority. Train owner's operations and maintenance staff.

END OF SECTION

SECTION 238126
SPLIT-SYSTEM AIR-CONDITIONERS

SECTION 23 81 26

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 GENERAL

3.01 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2027.

3.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

3.03 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

3.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Sustainable Design Submittals:
   1. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

3.05 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

3.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

3.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set(s) for each air-handling unit.
   2. Gaskets: One Insert number set(s) for each access door.
   3. Fan Belts: One set(s) for each air-handling unit fan.

3.08 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

3.09 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

3.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period:
      a. For Compressor: Five year(s) from date of Substantial Completion.
      b. For Parts: Five year(s) from date of Substantial Completion.
      c. For Labor: Five year(s) from date of Substantial Completion.

PART 2 PRODUCTS

4.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trane
   2. Carrier Corporation.
   3. Mitsubishi Electric & Electronics USA, Inc.

4.02 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:
   1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
   2. Insulation: Faced, glass-fiber duct liner.
   3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
   4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.54 mm); leak tested to 300 psig (2068.43 kPa) underwater; with a two-position control valve.
   5. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
   6. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
   7. Fan Motors:
      a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
      b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
      c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
9. Filters: Permanent, cleanable.
10. Condensate Drain Pans:
    a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
        1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
        2) Depth: A minimum of 2 inches (50.8 mm) deep.
    b. Double-wall, galvanized-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
    c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
        1) Minimum Connection Size: NPS 1.
    d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
    e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

B. Floor-Mounted, Evaporator-Fan Components:
1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.
    a. Discharge Grille: Steel with surface-mounted frame.
    b. Insulation: Faced, glass-fiber duct liner.
    c. Drain Pans: Galvanized steel, with connection for drain; insulated.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive, centrifugal.
5. Fan Motors:
    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
6. Air Filtration Section:
    a. General Requirements for Air Filtration Section:
        1) Comply with NFPA 90A.
        2) Minimum MERV according to ASHRAE 52.2.
        3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

C. Wall-Mounted, Evaporator-Fan Components:
1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

4. Fan: Direct drive, centrifugal.
5. Fan Motors:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   c. Enclosure Type: Totally enclosed, fan cooled.
   d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
   e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
   f. Mount unit-mounted disconnect switches on exterior of unit.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Condensate Drain Pans:
   a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
      1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
      2) Depth: A minimum of 1 inch (25.4 mm) deep.
   b. Single-wall, galvanized-steel sheet.
   c. Double-wall, galvanized-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
   d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
      1) Minimum Connection Size: NPS 1 Insert size.
   e. Pan-Top Surface Coating: Asphaltic waterproofing compound.

4.03 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:
   1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
   2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
      a. Compressor Type: Scroll.
      b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
      c. Refrigerant: R-410A.
      d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
   3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
   4. Fan: Aluminum-propeller type, directly connected to motor.
   5. Motor: Permanently lubricated, with integral thermal-overload protection.
   6. Low Ambient Kit: Permits operation down to 45 deg F.
   7. Mounting Base: Polyethylene.

4.04 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
   1. Compressor time delay.
   2. 24-hour time control of system stop and start.
   3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
   4. Fan-speed selection including auto setting.

D. Automatic-reset timer to prevent rapid cycling of compressor.

E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

F. Drain Hose: For condensate.

G. Monitoring:
   1. Monitor constant and variable motor loads.
   2. Monitor variable-frequency-drive operation.
   3. Monitor economizer cycle.
   4. Monitor cooling load.
   5. Monitor air distribution static pressure and ventilation air volumes.

PART 3 EXECUTION

5.01 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. Equipment Mounting:
   1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
   3. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
   4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

5.02 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

5.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

5.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

5.05 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

DIVISION 250000
INTEGRATED AUTOMATION

PART 1 GENERAL

A. The System shall provide the Direct Digital Control (DDC), Energy Management System (EMS) and Building Automation System (BAS) for HVAC systems and shall interface with other microprocessor-based building subsystems as necessary to support effective control of Energy- Management Systems and HVAC systems.

B. Harris County operates under two Web-accessible user interfaces: WebView, manufactured by Reliable Controls and WebCTRL manufactured by Automated Logic Corporation (ALC).

C. Approved Vendors and contacts :
   1. Automated Logic Corporation (Installed by Branch Office) (Office: 281.837.0777).
   2. Reliable Controls by Unify Energy Solutions (Office: 281.477.0777)

1.02 SYSTEM REQUIREMENTS

A. All material and equipment used shall be standard components, regularly available, and not custom designed especially for a project.

B. The system architecture shall be fully modular permitting expansion of application software, system peripherals, and field hardware.

1.03 SYSTEM HARDWARE

A. Provide the following:
   1. All Control Modules as specified.
   2. All sensing devices, relays, switches, indicating devices, and transducers required to perform the functions as listed in the I/O Summary Tables.
   3. All monitoring and communication control wiring and raceways.
   4. Electrical power sources as required for a complete and fully functional control system. Coordinate with Division 26.

1.04 SYSTEM SOFTWARE

A. The Controls Contractor shall provide all software identified including connection to the existing ALC Server or Reliable Server, fully configured database, graphics, thermal graphic floor space diagram, reports, and alarm/events. The Graphical User Interface (GUI) shall be completely Web based as specified herein.

1.05 INPUT / OUTPUT POINT SUMMARY SCHEDULE

A. The system as specified shall monitor, control, and calculate all of the points and perform all the functions as listed in the I/O Point Summary Schedule attached as Appendix A to this specification.

1.06 BAS USER'S MANUAL

A. The BAS User's Manual shall contain as a minimum:
   1. System overview. Networking concepts.
   2. Launching a web browser from a networked PC and login.
   3. Web Browser Graphical User Interface (GUI) screen menus and their definitions. Creating, modifying or deleting schedules.
   4. Uploading and downloading software to the field hardware.
   5. Creating historical trends, collecting trend data and generating trend graphs. Enabling and assigning alarms and messages to reporting actions/groups.
   6. Report generation and ‘third party software’. Backing up software and data files.

1.07 PROJECT ENGINEERING MANUAL

A. The Project Engineering Manual for Harris County shall contain as a minimum: System architecture overview and networking configuration.

B. Hardware cut-sheets and product descriptions.

C. All drawings shall be reviewed after the final system checkout and updated to provide 'as-built' drawings. The system will not be considered complete until the 'as-built' drawings have received their final approval.

D. Installation, mounting and connection details for all field hardware and accessories. Commissioning, setup and backup procedures for all control modules/accessories, BAS server software, and database.

E. Listing of basic terminology, alarms/messages, error messages and frequently used commands or shortcuts.

1.08 BAS SOFTWARE DOCUMENTATION

A. BAS Software Documentation shall contain as a minimum:

B. The Contractor shall provide all Graphical Programs, detailing their application to specific HVAC equipment and electrical/mechanical subsystems, together with a glossary or icon symbol

C. library detailing the function of each graphical icon. Revisions made as a result of the submittal process, during the installation, start-up or acceptance portion of the project, shall be accurately reflected in the "as-build" documents.

D. Graphical representation of the mechanical equipment hierarchy for the project including all equipment controlled by the BAS. For example: a VAV terminal box may be the source for increased cooling demand and require the primary VAV AHU to operate which, in turn, requires the chillers to operate.

E. Detailed listing of all alarm and event messages programmed for designate mechanical/electrical equipment and required operator action.

1.09 COMMISSIONING AND ACCEPTANCE TESTING

A. Upon completion of the installation, the Contractor shall start up the system and perform all necessary calibration, testing, and debugging operations. The Contractor in the presence of the County's representative shall perform an acceptance test.

B. The Contractor shall commission the entire BAS control system in compliance with International Energy Conservation Code (IECC) requirements and in accordance with ASHRAE Guideline 0 standards. Commissioning must include full functional testing of the BAS system. The Contractor shall promptly remedy functional testing deficiencies and retest until compliance is achieved. The Contractor shall submit a final commissioning report upon completion.

1.10 SYSTEM TRAINING

A. Controls Contractor shall provide full Computer Based Training (CBT) in addition to training of designated personnel in the operation, maintenance, and programming of the system.

PART 2 SUSTAINABILITY CONSIDERATIONS FOR INTEGRATED AUTOMATION

A. Implement optimum start control for air handling units (AHU). Widen thermostat temperature deadband and setbacks during unoccupied hours.

B. Disable OA ventilation to air handling units during unoccupied setback operation equipment engagement.

PART 3 BAS SERVER AND WEB BROWSER GUIDE

3.01 SYSTEM OVERVIEW

A. The BAS contractor shall provide system software based on a server/thin-client architecture, designed around the open standards of web technology. The BAS server shall communicate using ASHRAE's BACnet/IP protocol, and in addition, offer concurrent support over the

same data-link of the following protocols: LonWorks, MODBUS, and SNMP. Server shall be accessed using a web browser over Harris County intranet and remotely over the Internet.

B. The intent of the thin-client architecture is to provide the operator(s) complete access to the BAS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support the following:

Windows®	Google™ Chrome™ v66.0 or later Internet Explorer® v11 Desktop Microsoft® Edge v40 or later Mozilla® Firefox® v60.0 or later
Mac® OS X® (Apple® Mac only)	Safari® v11 or later [2] Google Chrome v66.0 or later Mozilla Firefox v60.0 or later
Linux®	Google Chrome v66.0 or later Mozilla Firefox v60.0 or later

C. No special software, (active-x components or fat java clients) shall be required to be installed on the PC's / PDA's used to access the BAS via a web browser.

D. The BAS server software must support at least the following server platforms (Windows NT, Sun Solaris and Linux). The BAS server software shall be developed and tested by the manufacturer of the system standalone controllers and network controllers/routers. Third party manufactured and developed BAS software is not acceptable.

E. The web browser GUI shall provide a completely interactive user interface and must offer the following features as a minimum:
1. Trending Scheduling
2. Real time 'live' Graphic Programs Parameter change of properties Setpoint Adjustments
3. Alarm / Event information

3.02 SOFTWARE COMPONENTS

A. All of the BAS system software components shall be installed and completed in accordance with the specification. BAS system components shall. at a minimum, include:
1. Server Software, Database and Web Browser Graphical User Interface System Configuration Utilities for future modifications to the system Programming Tools
2. Direct Digital Control (DDC) software Application Software

3.03 BAS SERVER DATABASE

Database	Operating systems supported	Speed	Supports multiple servers	Dynamic defrag-mentation	Database replication	Notes
SQL Server® Express 2017, 2016, 2014	Windows®	Fast	No	Yes	Yes	Database cannot exceed 10 GB.
SQL Server® 2017, 2016, 2014	Windows®	Fast	Yes	Yes	Yes	SQL Server® 2016 Enterprise, Business Intelligence, and Standard editions can be used. SQL Server® 2014 Enterprise, Business Intelligence, and Standard editions can be used.

3.04 COMMUNICATION PROTOCOL(S)

A. The native protocol for the BAS Server software shall be BACnet over Ethernet DataLink as defined by ASHRAE standard SPC135. The BAS Server shall support BACnet/IP Annex J to

enable communication through common routers. Proprietary protocols over TCP/IP are NOT acceptable.

3.05 CROSS PLATFORM CAPABILITY

A. The BAS software (client and server) shall utilize:
   1. Windows 10 Professional
   2. Windows 8.1 Professional and Enterprise
   3. Windows 7 Professional and Ultimate
   4. Windows Server 2016
   5. Windows Server 2012 R2
   6. Red Hat Enterprise Linux 7.4*
   7. Ubuntu Desktop 16.04 LTS*

3.06 THIN CLIENT

A. The GUI shall be thin-client or browser-based and shall meet the following criteria:
   1. Web Browser's for PC's - Only Internet Explorer 8.0 or higher will be required as the GUI, and a valid connection to the server network. Connection shall be over an intranet or the Internet.
   2. Secure Socket Layers - Communication between the Web Browser GUI and BAS server shall offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL).
   3. Communication protocol shall be Hyper-Text Transfer Protocol (HTTP).
   4. PDA's - BAS Server software must support other browsers used by Personal Digital Assistants like IPad and other Internet appliances specified below.

Device type	Platform support
Smart phone	Android™, iOS
Tablet	Android™, iOS, Surface™

PART 4 WEB BROWSER GRAPHICAL USER INTERFACE

4.01 WEB BROWSER NAVIGATION

A. The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish 2.2 B thru 2.2 J of this specification. The Web Browser GUI shall (as a minimum) provide a Navigation Pane or overall Building Summary for navigation, and an Action Pane for display of animated graphics, schedules, alarms/events, active graphic setpoint controls, configuration menus for operator access, reports, and reporting actions for events.

B. Web pages generated by this server shall be compatible with the latest versions of Microsoft Internet Explorer or Edge, Google Chrome, Mozilla Firefox, and Apple Safari browsers. Any of these supported browsers connected to the server shall be able to access all system information. Mobile devices shall be recognized by the web server and shall supply the appropriate system content as needed. The Operator Interface (web server with client devices) shall conform to the BACnet Operator Workstation (B-OWS) or BACnet Advanced Workstation (B-AWS) device profile as specified in ASHRAE/ANSI 135 BACnet Annex L. This includes the ability to configure and/or reconfigure the system from the client device (change programs, graphics, labels, etc.).

4.02 LOGIN

A. On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and password.

B. Navigation in the system shall be dependent on the operator's role privileges, and geographic area of responsibility (see 3.2 J below).

4.03 NAVIGATION PANE

A. The Navigation Pane shall comprise a Navigation Tree which defines a geographic hierarchy of Harris County BAS system. Navigation through the GUI shall be accomplished by clicking on appropriate level of a navigation tree (consisting of expandable and collapsible tree control like Microsoft's Explorer program), and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane defined in 2.2 D shall be displayed simultaneously, enabling the operator to select a specific system or equipment, and view the corresponding graphic.

4.04 ACTION PANE

A. The Action Pane shall provide a functional view for each HVAC or mechanical/electrical subsystem specified. A functional view shall be accessed by clicking on the area in the navigation pane or action pane. Action pane shall default to a graphical view of the area or subsystem, and will also have a link to display a system properties view for parameter changes.

4.05 GRAPHICS

A. Using animated gifs or other graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic setpoint controls, web content, and other valid HTML elements. The data on each graphic page shall automatically refresh at a rate defined by the operator.

4.06 PROPERTIES

A. Shall include text for the following: Locking or overriding BACnet objects, demand strategies, and any other valid data required for setup.

4.07 SCHEDULES

A. Shall be used to create, modify/edit and view schedules.

4.08 TRENDS

A. Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling other actions such as Print, Help, Command, and Logout shall be available via a drop- down window.

4.09 COLOR GRAPHICS

A. The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to setpoints and comfort. Animated .gif's or .jpg, active setpoint graphic controls shall be used to enhance usability. Graphics tools used to create Web Browser graphics shall be non-proprietary and conform to the following basic criteria:

B. Display Size. The GUI workstation software shall graphically display in 1920 by 1080 pixels 24 bit True Color

C. General Graphic. General area maps shall show locations of controlled buildings in relation to local landmarks

D. Minimum System Color Graphics. Color graphics shall be selected and displayed via a web browser for the following

E. Each piece of equipment monitored or controlled including each terminal unit. Each building.

F. Each floor and zone controlled.

G. Color Floor Plans. Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, which provide a visual display of temperature relative to their respective setpoints. The colors shall be updated dynamically as a zone's actual comfort condition changes.

H. Mechanical Components. Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components.

I. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability.

J. Zone Setpoint Adjustments - Color floor plans displayed via a web browser shall utilize a contiguous band of colors, each corresponding to actual zone temperatures relative to the desired heating and cooling setpoints.

K. The "ideal" temperature shall be shown as a green color band. Temperatures warmer than ideal shall be shown in orange.

L. Temperatures cooler than ideal shall be blue. All alarm colors shall be in red.

4.10 SCHEDULES

A. Utilizing the graphics displayed in the web browser GUI, an operator (with password access) shall be able to click the schedule icon for an area, building, or piece of equipment to download a BACnet schedule for the that area.

B. BACnet Schedules. Schedules shall comply with the BACnet standard, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:

C. Types of schedule shall be Normal, Holiday or Override. A specific date,

D. A range of dates,

E. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M- Sun, Any).

F. Recurrence (example, allow combinations like second Tuesday of every month).

G. Schedule Calendars. Operators shall be able to save schedule calendars for operating the same schedule of occupancy or un-occupancy times over several different days.

H. Click and Drag. Operators shall be able to schedule times and dates via a simple click and drag interface in the schedule window.

I. Partial Day Exceptions. Schedule events shall be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).

J. Schedule Distribution. For reliability and performance, instead of maintaining a single schedule in a field device that writes over the network to notify other devices when a scheduled event occurs, field devices will only keep their part of the schedule locally. The BAS server software shall determine which nodes a hierarchical schedule applies to and will create/modify the necessary schedule objects in each field device as necessary.

4.11 ALARMS / EVENTS

A. Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting Alarms from the “More” drop down menu.

B. Alerts. Alerts specified shall be automatically launched (under certain conditions) after an event is received by the BAS server software. Reporting Actions shall be as follows:
   1. Print. Alarm/Event information shall be printed to the BAS server’s PC or a networked printer.
   2. Email. Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts.
   3. Note: Where email servers support pagers, email reporting action shall also be used to support alphanumeric paging services.

4. File Write. The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).Each event shall display an Event Category (using a different icon for each event category), date/time of occurrence, current status, event report, and a bold URL link to the associated graphic for the selected system, area or equipment . The URL link shall indicate the system location, address and other pertinent information. An operator shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
5. BACnet Event Templates. BACnet Event template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of event, acknowledgement requirements, high/low limit and out of range information.
6. Event Time/Date Stamp. All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
7. Event Configuration. Operators shall be able to define the type of events generated per BACnet object. Configuration shall include assignment of event, alarm, type of Acknowledgement and notification for return to normal or fault status.
8. Event Auto-Deletion. Events that are acknowledged and closed, shall be auto-deleted from the database and archived to a text file after an operator defined period.

4.12 TRENDS

A. Trends shall conform to the BACnet Trend Log Object specification. Trends shall both be displayed and user selectable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously.

B. Viewing Trends. The operator shall have the ability to view trends by clicking the trend link or icon when viewing a piece of equipment.

C. Local Trends. Trend data shall be collected locally by Multi- Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if RC-Archive is enabled for the BACnet object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.

D. Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for display that have different trend intervals, the system will automatically scale the axis.

E. Dynamic Update. Trends shall be able to dynamically update at operator defined intervals.

F. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and ‘pan through’ historical data by simply scrolling the mouse.

G. Copy/Paste. The operator must have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).

4.13 SECURITY ACCESS

A. Systems that access from the web browser GUI to BAS server shall require a Login Name and Password. Access to different areas of the BAS system shall be defined in terms of Roles, Privileges and geographic area of responsibility as specified:

B. Roles. Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of ‘easily understood English language’ privileges. Roles shall be defined in terms of View, Edit and Function Privileges.

C. View Privileges shall comprise. Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.

D. Edit Privileges shall comprise. Setpoint, Tuning and Logic, Manual Override, and Point Assignment Parameters.

E. Function Privileges shall comprise. Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print, and Alarm/Event Maintenance.

F. Geographic Assignment of Roles. Roles shall be able to be assigned for users. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

PART 5 PRODUCTS - COMMUNICATIONS HARDWARE

A. BAS Server Hardware - Computer Configuration (Hardware Independent)

B. Central Server – Utilize Owner's existing BAS server platform. All control database modifications shall be installed on this server.

5.02 NETWORK ROUTERS & BRIDGES

A. The controller network shall use BACnet as its native communication protocol. Network bridges and routers must be of a modular design to ensure reliability and system performance.

5.03 BACNET ROUTER

A. The central system shall use the building Local Area Network (LAN) for communication. The communication between the central server and the controllers shall be BACnet/IP. A router shall be provided, as required, to bridge BACnet/IP and the data link used between the controllers (BACnet over MS/TP). Proprietary protocols are NOT acceptable.

B. BACnet Interoperability Building Blocks (BIBBs) - allow matching project requirements to the capabilities of the devices being installed

C. BACnet Routers must use BACnet as the native communication protocol and must, as a minimum, support the following BIBBS:

BACnet Router BIBBs	
Data Sharing (DS)	
DS-RP-A	Read Property - A
DS-RP-B	Read Property - B
DS-RPM-B	Read Property Multiple - B
DS-WP-A	Write Property - A
DS-WP-B	Write Property - B
DS-WPM-B	Write Property Multiple - B
DS-COVU-A	Change of Value Unsubscribed - A
DS-COVU-B	Change of Value Unsubscribed - B
Alarm / Event Management (AE)	
AE-N-B	Notification - B
AE-ACK-B	Acknowledgement - B
AE-ASUM-B	Alarm Summary - B
Scheduling (SCHED)	
SCHED-B	Schedule - B

Trending (T)

T-VMT-B	Viewing and Modifying Trends - B
T-ATR-B	Automated Trend Retrieval - B

Data / Network Management (DM)

DM-DDBA	Dynamic Device Binding - A
DM-DOB-B	Dynamic Object Binding - A
DM-DCCB	DDevice Communication Control - B

Network Management (NM)

NM-RC-A	Network Router Configuration - A

5.04 FIRMWARE UPDATES

A. The BACnet Router shall utilize FLASH memory to allow firmware updates to be performed remotely.

PART 6 STANDALONE CONTROLLERS

6.01 GENERAL PURPOSE MULTIPLE APPLICATION CONTROLLERS (MACS).

A. BIBBs - General Purpose MACs must use BACnet as the native communication protocol between controllers and must, as a minimum, support the following BIBBS:

General Purpose Multiple Application BIBBs

Data Sharing (DS)

DS-RP-A	Read Property - A
DS-RP-B	Read Property - B
DS-RPM-B	Read Property Multiple - B
DS-WP-A	Write Property - A
DS-WP-B	Write Property - B
DS-WPM-B	Write Property Multiple - B
DS-COVU-A	Change of Value Unsubscribed - A
DS-COVU-B	Change of Value Unsubscribed - B

Alarm / Event Management (AE)

AE-N-B	Notification - B
AE-ACK-B	Acknowledgement - B
AE-ASUM-B	Alarm Summary - B

Scheduling (SCHED)

SCHED-B	Schedule - B

Trending (T)

T-VMT-B	Viewing and Modifying Trends - B
T-ATR-B	Automated Trend Retrieval - B

Data / Network Management (DM)

DM-DDBA	Dynamic Device Binding - A
DM-DDBB	Dynamic Device Binding - B
DM-DOB-B	Dynamic Object Binding - A
DM-DCCB	Device Communication Control - B
DM-TS-B	Time Synchronization - B
DM-UTC-B	UTC Time Synchronization - B
DM-RD-B	Reinitialize Device - B

Network Management (NM)

NM-RC-A	Network Router Configuration - A

B. Communication Speed
   1. Controllers shall communicate at a minimum of 76.8 Kbps using BACnet over MS/TP implemented over EIA-485 using a shielded twisted pair at the Data Link Layer.

C. General Specification
   1. Each General Purpose MAC must be capable of standalone direct digital operation utilizing its own 32 bit processor, non-volatile flash memory, input/output, 12 bit A to D conversion, hardware clock/calendar and voltage transient and lightning protection devices. A separate co- processor shall be used for communications to the controller network. All non-volatile flash memory shall have a battery backup of at least five years. Firmware revisions to the module shall be made from the BAS server or remotely over the Intranet or Internet. Controllers that require component changes to implement firmware revisions are NOT acceptable.

D. Point Expansion
   1. The General Purpose MACs shall be expandable to the specified I/O point requirements. Each controller shall accommodate multiple I/O Expander Modules via a designated expansion I/O bus port. These expander modules shall expand the total point capacity of each controller up to 192 points where specified. The controller, in conjunction with the expansion modules, shall act as one standalone controller.

E. Point Programming
   1. All point data, algorithms and application software within a controller shall be custom programmable from the operator workstation.

F. Program Execution
   1. Each General Purpose MAC shall execute application programs, calculations, and commands via a 32-bit microcomputer resident in the controller. All operating parameters for application programs residing in each controller shall be stored in read/writable nonvolatile flash memory within the controller and will be able to upload/download to/from the BAS Server.

G. Self-Test Diagnostics
   1. Each controller shall include self-test diagnostics, enabling the controller to report malfunctions to the router and BAS Server.

H. PID Loops
   1. Each General Purpose MAC shall contain both software and firmware to perform full DDC Proportional, Integral, Derivative (PID) control loops and programs.

I. Input-Output (I/O) Processing
   1. Outputs shall be universal, capable of providing analog or digital signals and capable of being triac or relay outputs. Each output shall have indicator lights on or off for digital outputs and various stages of dimming for analog outputs. Each output shall

have override capability by HOA switch for digital outputs and by set screw for analog outputs. Feedback shall be generated in the software to show if point has been put in hand at the controller.

2. Universal Inputs shall be Thermistor (BAPI Curve II) 10K Ohm at 77□F (25□C), 0-5VDC, 10K Ohm maximum source impedance, 0- 20mA - 24 VDC loop power, 250 Ohm input impedance, dry contact - 0.5mA maximum current.

6.02 GENERAL PURPOSE SINGLE APPLICATION CONTROLLERS

A. BIBBs. - The General Purpose Single Application Controllers must use BACnet as the native communication protocol between controllers and must, as a minimum, support the following BIBBS.

General Purpose Single-Application BIBBs	
Data Sharing (DS)	
DS-RP-A	Read Property - A
DS-RP-B	Read Property - B
DS-RPM-B	Read Property Multiple - B
DS-WP-A	Write Property - A
DS-WP-B	Write Property - B
DS-WPM-B	Write Property Multiple - B
DS-COVU-A	Change of Value Unsubscribed - A
DS-COVU-B	Change of Value Unsubscribed - B
Alarm / Event Management (AE)	
AE-N-B	Notification - B
AE-ACK-B	Acknowledgement - B
AE-ASUM-B	Alarm Summary - B
Scheduling (SCHED)	
SCHED-B	Schedule - B
Trending (T)	
T-VMT-B	Viewing and Modifying Trends - B
T-ATR-B	Automated Trend Retrieval - B
Data / Network Management (DM)	
DM-DDB-A	Dynamic Device Binding - A
DM-DDB-B	Dynamic Device Binding - B
DM-DOB-B	Dynamic Object Binding - A
DM-DCC-B	Device Communication Control - B
DM-TS-B	Time Synchronization - B
DM-UTC-B	UTC Time Synchronization - B
DM-RD-B	Reinitialize Device - B
Network Management (NM)	

B. Communication Speed
   1. Controllers shall communicate at a minimum of 76.8 Kbps using MS/TP implemented over EIA- 485 using an unshielded twisted pair at the Data Link Layer.

C. General Specification
   1. General Purpose Single Application controllers must be capable of stand-alone DDC operation utilizing its own 32 bit processor, nonvolatile flash memory, input/output, 8 bit A to D conversion, hardware clock/calendar and voltage transient protection devices. A separate coprocessor shall be used for communications to the controller network. All RAM memory shall have a battery backup of at least five years. Firmware revisions to the module shall be made from the BAS server, or remote locations over the Internet. Controllers that require component changes to implement Firmware revisions are NOT acceptable.

D. Point Programming
   1. All point data, algorithms, and application software within the controllers shall be custom programmable from the Operator Workstation.

E. Program Execution
   1. Each General Purpose Single Application Controller shall execute application programs, calculations, and commands via a 32-bit microcomputer resident in the controller. All operating parameters for the application program residing in each controller shall be stored in read/writable nonvolatile flash memory within the controller and will be able to upload/download to/from the Operator Workstation.

F. Self-Test Diagnostics
   1. Each controller shall include self-test diagnostics, enabling the controller to report malfunctions to the router and BAS Server input.

G. PID Loops
   1. Each General Purpose Single Application Controller shall contain both software and firmware to perform full DDC PID control loops.

H. Rooftop Mounting
   1. The General Purpose Single Application Controllers shall be capable of being mounted directly in or on rooftop AHU equipment.

I. Operating Temperature
   1. The General Purpose Single Application Controllers shall be capable of proper operation in an ambient temperature environment of -20 deg F to +150 deg F (-28.9 deg to 65.6 deg C).

J. Input-Output Processing
   1. Outputs shall be universal capable of providing analog or digital, and capable of being triac or relay outputs. Each output shall have indicator lights on or off for digital outputs and various stages of dimming for analog outputs.
   2. Universal Inputs shall be Thermistor (BAPI Curve II) 10K Ohm at 77□F (25□C), 0-5VDC - 10K Ohm maximum source impedance, 0- 20mA - 24 VDC loop power, 250 Ohm input impedance, Dry Contact - 0.5mA maximum current.

PART 7 UNITARY CONTROLLER NETWORK

7.01 UNITARY CONTROLLERS

A. BACnet BIBBS. The Unitary Controllers shall use BACnet as the native communications protocol between controllers on the unitary controller network and must, as a minimum support the following BIBBS:
   1. DS-RP-B, DM-D-B
   2. DS-WP-B, DM-PT-B

7.02 COMMUNICATION SPEED.

A. The communication between unitary controllers shall be 76.8 Kbps minimum over EIA-485 using an MS/TP architecture.

7.03 SENSOR SUPPORT

A. Each Unitary Controller shall be able to support various types of zone temperature sensors, such as; temperature sensor only, temperature sensor with built-in local override switch and temperature sensor with built-in setpoint adjustment switch.

7.04 AIRFLOW TRANSDUCER

A. In order to provide reliable Pressure-Independent VAV operation, Unitary Controllers for pressure-independent VAV applications shall have a precision built-in Honeywell AWM series airflow transducer for accurate airflow measurement.

7.05 INTEGRAL ACTUATOR

A. Each Unitary Controller for VAV applications shall have an integral direct coupled electronic actuator with the following features:
   1. The actuator shall provide on-off/floating point control with a minimum of 35 in-lbs. of torque.
   2. The assembly shall mount directly to the damper-operating shaft with a universal V- Bolt clamp assembly.
   3. The actuator shall not require any limit switches, and shall be electronically protected against overload.
   4. The actuator shall automatically stop when reaching the damper or actuator end position. The gears shall be capable of being manually disengaged with a button on the assembly cover. A visual pointer for the position of the actuator.
   5. The assembly shall have an anti-rotational strap supplied with the assembly that will prevent lateral movement.
   6. 5-year warranty from the manufacturer.

Visual Status

   7. Each Unitary Controller and Unitary Controller Interface shall have LED indication for visual status of communication, power, and all outputs.

7.06 STANDALONE ALGORITHM

A. In the event of a loss of communication, each Unitary Controller shall control from a standalone algorithm, which maintains the assigned space temperature until communication with the Unitary Control Router is restored.

7.07 INPUT/OUTPUT PROCESSING.

A. Digital outputs shall be relays, 24 Volts AC or DC maximum, having a 1 Amp maximum current. Each relay shall be configured as normally open or normally closed, and provide a dry contact. Triac outputs are NOT acceptable.

B. Universal inputs shall be Thermistor Precon Type II, dry contacts or 0-5VDC with 0-10K Ohm input impedance.

C. Enhanced Zone Sensor Input. The input shall provide one thermistor input, one local setpoint adjustment, one timed local override switch, and an occupancy LED indicator.

D. Analog output electronic, voltage mode 0-10VDC.

DS-RP-A

DS-RP-B

AE-N-B

SCHED-B

T-VMT-B

DM-DDB-A

DM-DDB-B

DS-RPM-B

AE-ACK-B

T-ATR-B

DM-DOB-B

DS-WP-A

DS-WP-B

AE-ASUM-B

DM-DCC-B

DS-WPM-B

DM-TS-B

DS-COVU-A

DS-COVU-B

DM-UTC-B

DM-RD-B

PART 8 UNITARY CONTROLLER ROUTER

A. A router shall be provided to bridge between the unitary controller network and the main controller network, as required.

8.02 BACNET BIBBS

A. The Unitary Controllers Routers shall use BACnet as the native communications protocol between controllers on the unitary controller network and must, as a minimum support the following BIBBs:

8.03 PROTOCOL TRANSLATOR MODULE (PTM)

A. The BAS shall establish a seamless interconnection with other building, electrical and/or mechanical subsystems as well as other manufacturers control systems using a Protocol Translator as specified below and related equipment sections of the specification. These systems shall be controlled, monitored and programmed with the same programming language used for all other control modules. PTM shall be specified as follows:
   1. The PTM shall be a microprocessor-based communication device designed to provide seamless, two-way translation between two or more standard or non-standard protocols.
   2. The PTM shall communicate BACnet over MS/TP.
   3. In addition to BACnet, the PTM shall also support other protocols including Modbus, J-Bus and other protocols as specified herein for electrical/mechanical subsystems.
   4. The PTM shall have at least three communication ports. One shall be for communication between native BACnet controllers residing on the controller network. The other two ports shall have the ability to be configured for different protocols.
   5. The PTM shall provide full custom programmability of the data flowing between the networks using the same programming language as specified herein. The system shall have the ability to create custom building control strategies using global data between networks.

6. System Information
7. All system information specified in the I/O Point Summary and related documents shall be available to the BAS server.

8.04 OEM COOPERATION

A. Full cooperation by the Original Equipment Manufacturer (OEM) in this open protocol effort shall be a requirement for bidding this project. OEMs shall bid BACnet. OEMs that utilize other protocols shall include the cost of a BACnet Translation Module (BTM) in their bid. Any OEM using the LonWorks protocol shall certify their devices are LONMARK-compliant.

8.05 NECESSARY EQUIPMENT INCLUDED PRICE

A. If the equipment manufacturer does not have this capability, they shall contact the authorized representative of the BAS for assistance and shall include in their equipment price any necessary equipment obtained from the BAS manufacturer to comply with this section.

PART 9 INPUT DEVICES /INSTRUMENTATION

9.01 TEMPERATURE SENSORS.

A. Sensors shall be of the type and have accuracy ratings as indicated and/or required for the application and shall permit accuracy rating of within 1% of the temperature range of their intended use.

9.02 SENSORS USED FOR MIXED-AIR APPLICATIONS

A. Sensors shall be the averaging type and have an accuracy of +1 deg F.

9.03 OA TEMPERATURE SENSORS

A. Sensors shall have a minimum range of - 52 deg F to 152 deg F and an accuracy of within

B. +1 deg F in this temperature range.

9.04 ROOM TEMPERATURE SENSORS

A. Sensors shall have an accuracy, of +0.25 deg F in the range of 45 deg F to 96 deg F.

9.05 CHILLED WATER AND CONDENSER WATER SENSORS

A. Sensors shall have an accuracy of +0.25 deg F in their range of application.

9.06 HOT WATER TEMPERATURE SENSORS

A. Sensors shall have an accuracy of +0.75 deg F over the range of their application.

9.07 HUMIDITY SENSORS

A. Sensors shall have an accuracy of ±5% over a range of 20% to 95% RH.

9.08 DIFFERENTIAL PRESSURE AND PRESSURE SENSORS.

A. Sensors shall have a 4-20mA output proportional signal with provisions for field checking. Sensors shall withstand up to 150% of rated pressure, without damaging the device. Accuracy shall be within ±2% of full scale. Sensors shall be manufactured by Leeds & Northrup, Setra, Robertshaw, Dwyer Instruments, Rosemont, or be approved equal.

9.09 WATER DIFFERENTIAL PRESSURE SWITCHES

A. Pressure switches shall have a repetitive accuracy of ±2% of range and withstand up to 150% of rated pressure. Sensors shall be diaphragm or bourbon tube design. Switch operation shall be adjustable over the operating pressure range. The switch shall have an application rated Form C, snap-acting, self-wiping contact of platinum alloy, silver alloy, or gold plating. Switches shall be manufactured by Honeywell, Johnson Controls, MCC Powers, Dwyer Instruments, or be approved equal.

9.10 HIGH STATIC LIMIT SWITCH

A. Switches shall be diaphragm operated with 3-1/2" diaphragm to actuate a single pole double throw snap switch. Motion of the diaphragm shall be transmitted to the switch button by

means of a direct mechanical linkage. It should include a 1.4 – 5.5" w.c. range pressure switch with manual reset snap switch. Dwyer 1900-5-MR or approved equal.

9.11 STATIC PRESSURE SENSOR

A. Provide a differential pressure transmitter with a 4-20mA output to the BAS. It shall operate on the capacitance principle and be capable of sensing very low positive, negative or differential pressures. In the capacitance cell, and lightweight pressures. In the capacitance cell, a lightweight diaphragm shall deflect a small amount when pressure is applied. This deflection creates a change in capacitance, which is then detected and processed electronically.

B. (Modus T-30 or approved equal.)

C. Accuracy: ±1% of range Ranges: 5.0"/12.5 mbar Operating temp range: 32º to 125º F

D. Operating humidity range: 20% to 90% RH noncondensing

9.12 FLOW SWITCHES

A. Flow switches shall have a repetitive accuracy of ±1% of their operating range. Switch actuation shall be adjustable over the operating flow range. Switches shall have snap-acting Form C contacts rated for the specific electrical application.

9.13 FLOW SENSOR

A. Provide brass Hot Tap flow sensor that features an elongated sensor, pipe nipple, and gate type isolation valve to allow the nonmagnetic impeller sensor to be installed into a pressurized pipe while the pipe is in service. Provide analog transmitter to convert the flow to a 4-20mA signal. (Data Industrial 225B or approved equal.)

9.14 WATT-HOUR TRANSDUCERS

A. Watt-hour transducers shall have an accuracy of ±0.25% for kW and kWh outputs from full lag to full lead power factor. Input ranges for kW and kWh transducers shall be selectable without requiring the changing of current or potential transformers, and shall have dry contact pulse accumulation.

9.15 VOLTAGE-TO-DIGITAL ALARM RELAYS

A. Relays shall monitor status of boiler or chiller safeties and overloads and shall be sized and connected so as not to impede the function of the monitored contacts. Switch shall have self-wiping, snap-acting Form C contacts rated for the application.

9.16 CURRENT SENSING RELAYS

A. Relays shall monitor status of motor loads. Switch shall have self-wiping, snap- acting Form C contacts rated for the application. The set point of the contact operation shall be field adjustable.

9.17 TIMED LOCAL OVERRIDE

A. Provide a push button momentary normally open switch. Flush mount cycle.

9.18 PHOTOCELL

A. Provide photocell with transmitter for 4-20mA output signal. Sensor shall be mounted in a waterproof enclosure. Unit shall be calibrated for 4mA at greater than 100 foot candles and 20mA at less than 0.1 foot candles.

PART 10 OUTPUT DEVICES

10.01 CONTROL RELAYS

A. Control relay contacts shall be rated for 150% of the loading application, with self-wiping, snap- acting Form C contacts, enclosed in dust proof enclosure. Relays shall have silver cadmium contacts with a minimum life span rating of one million operations. Relays shall be equipped with coil transient suppression devices.

10.02 SOLID STATE RELAYS (SSR)

A. Input/output isolation shall be greater than 10 billion ohms with a breakdown voltage of 15 V root mean square, or greater, at 60 Hz. The contact operating life shall be 10 million operations or greater. The ambient temperature range of SSRs shall be 20º F -140º F. Input impedance shall be greater than 500 ohms. Relays shall be rated for the application. Operating and release time shall be 10 milliseconds or less. Transient suppression shall be provided as an integral part of the relays.

10.03 MISCELLANEOUS

A. Provide and install all relays, switches, and all other necessary devices required for a complete and satisfactory operating system.

PART 11 DAMPERS

11.01 GENERAL

A. Provide all control dampers as indicated. Leakage rating at shutoff shall not be less than 1% of flow rate at 2000 fpm face velocity, with 4" w.c. pressure differential across damper.

11.02 FRAME

A. Galvanized steel, minimum 13 gauge, channel shaped for adequate strength.

11.03 BLADES

A. Dampers up to maximum 8" wide may se a single blade; multiple blade, opposed-action dampers shall be used for openings more than 8". Multi-blade dampers shall use blades not more than 8 inches in width. Blade material shall be galvanized steel, not less than 16 gage thickness, formed for extra strength. Provide replaceable rubber or santoprene edge seal, with spring loaded stainless steel side seal.

11.04 HARDWARE

A. Damper hardware shall be corrosion-resistant zinc plated steel or brass. Bearings shall be acetal or oilite. For dampers mounted in ducts, provide extended shafts for externally mounted operators.

PART 12 CONTROL DAMPER OPERATORS

12.01 GENERAL

A. Low-voltage electric actuator. Provide necessary linkage for proper operations of dampers. Belimo or approved equal.

12.02 TWO-POSITION DAMPERS

A. Provide sufficient quantity of operators, with adequate torque, to run damper through the full range of travel. Each section of the damper must completely close to the maximum leakage rate specified for the damper.

12.03 MODULATING DAMPERS

A. Operators shall be sized with sufficient reserve power to provide smooth modulating action. Actuator must be able to receive a 0-10 VDC control signal from the BAS. Modulating dampers shall have linear flow output characteristics.

PART 13 AUTOMATIC VALVES

13.01 PRESSURE RATINGS

A. 125 psig or 1.25 times the maximum system operating pressure.

13.02 CONSTRUCTION

A. Valves 2" and smaller :
   1. Screwed.
   2. Bodies and internal parts: Bronze, stainless steel or other approved corrosion-resistant metal. Valves 2-1/2" and larger :
   3. Flanged.
   4. Bodies. Cast iron or cast steel.

5. Seats and part exposed to fluid: Bronze, stainless steel or other approved corrosion-resistant metal.

13.03 MODULATING VALVES

A. Two-way - Valves shall be equal-percentage contoured throttling plugs and shall be globe valves only. Ball valves are not acceptable.

B. Three-way - Valves shall be linear throttling plugs allowing total flow through valve to remain constant regardless of position.

13.04 GENERAL

A. Valves intended for fully-modulating operation shall be provided by Manufacturer of project automatic control system.

B. Minimum pressure drop shall be equal to pressure drop of coil or exchanger being controlled. Maximum pressure drop: 5 psi.

C. Relief and by-pass valves shall be sized according to pressure available. Two-position valves shall be line-size unless otherwise noted.

D. Butterfly valves may be used in central plants for valves 4" and larger. Specific applications must be pre-approved by the Engineer.

PART 14 DDC SOFTWARE

14.01 OVERVIEW

A. The system shall continuously perform Direct Digital Control (DDC) functions at the local control module in a stand-alone mode. The operator shall be able to design and modify control sequence of operation and all tuning parameters.

14.02 MINIMUM FUNCTIONS

A. Each control module shall perform the following functions:
1. Identify, time/date stamp and report BACnet events Execute all application programs specified
2. Execute DDC algorithms Trend and store data

14.03 CONTROL FAILURE MODE

A. In the event of a control module failure, all points under its control shall be commanded to the failure mode as indicated on the I/O Summary Table. All DDC software shall reside in the respective control module.

14.04 ORDERLY SHUTDOWN

A. Power failures shall cause the control module to go into an orderly shutdown with no loss of program memory.

14.05 AUTOMATIC RESTART

A. Upon resumption of power, the control module shall automatically restart and print out the time and date of the power failure and restoration at the respective Workstation system.

14.06 AUTOMATIC RESTART

A. The restart program shall automatically restart affected field equipment. The operator shall be able to define an automatic power up time delay for each piece of equipment under control.

PART 15 APPLICATIONS SOFTWARE

15.01 GENERAL

A. All software application algorithms described below MUST reside at the local Multi-Application or Single- Application Controller level. Systems that rely on a workstation PC, server or router to perform these functions are NOT acceptable. The following applications software shall be provided for the purpose of optimizing energy consumption while maintaining occupant comfort:

15.02 TIME OF DAY SCHEDULING (TOD)

A. The system shall be capable of the following scheduling features:
   1. Schedule by Type. Scheduling by building, area, zone, groups of zones, individually controlled equipment and groups of individually controlled equipment. Each schedule shall provide beginning and ending dates and times (hours: minutes). A weekly repeating schedule, i.e. between 8:00 a.m. and 5:00 p.m., Monday through Friday shall constitute one schedule.
   2. Schedule in Advance. Dated schedules shall be entered up to 9 (nine) years in advance. Self-Deleting. Schedules shall be self-deleting when effective dates have pass
   3. Leap Year. Leap years shall be adjusted automatically without operator intervention.

15.03 OPTIMUM START/STOP (OSS)/OPTIMUM ENABLE/DISABLE (OED).

A. This application provides software to start and stop equipment on a sliding schedule based on the individual zone temperature and the heating/cooling capacity in °F/hour of the equipment serving that zone. The heating/cooling capacity value shall be operator adjustable. Temperature compensated peak demand limiting shall remain in effect during morning start up to avoid setting a demand peak.

15.04 SOURCE TEMPERATURE OPTIMIZATION (STO)

A. The system shall automatically perform source optimization for all air handling units, chillers and boilers in response to the needs of other downstream pieces of equipment, by increasing or decreasing supply temperature setpoints, i.e. chilled water, discharge air, etc. using County defined parameters. In addition to optimization, the STO capability shall also provide for starting and stopping primary mechanical equipment based on zone occupancy and/or zone load conditions.

15.05 SETPOINT RESET

A. The STO program shall allow setpoints for various equipment in the heating/cooling chain to be reset between an operator defined maximum and a minimum setpoint based on the actual requirements of the building zones. The actual setpoint shall be calculated based on the number of heating or cooling requests which are currently being received from the equipment or zones served. Once every update period, the STO program surveys the network to see if any piece of equipment requires any additional heating or cooling from its source.
   1. Example: - Q VAV air handler is the source of cold air for a number of VAV boxes. Assume that the STO program for the air handler has the following optimized setpoint parameters established for it by the County:
      a. Initial setpoint is 60.0 deg.,
      b. Max. setpoint is 65.0 deg.,
      c. Min. setpoint is 55.0 deg.,
      d. Every 2.0 mins, trim by 0.25 deg. and respond by -0.50 but no more than 2.0.

B. Every two minutes (time adjustable), the STO program shall total all of requests and calculate a new setpoints as follow:
   1. New setpoint = prev setpoint + 'trim by' + ('respond by' x no. of req.).
   2. Assuming four requests were received and the previous setpoint was 57.00 degrees, the new setpoint would be: New setpoint = 57.00 + 0.25 + (-0.50 x 4) = 55.25 Deg F
   3. If (the number of requests received) x (the 'respond by' value) > (the 'but no more than' value), use the 'but no more than' value inside the parenthesis in the above calculation.

15.06 DEMAND LIMITING (DL) - TEMPERATURE COMPENSATED

A. The DL application shall be programmable for a minimum of six separate time of day KW demand billing rate periods. The system shall be capable of measuring electrical usage from multiple meters serving one building and each piece of equipment being controlled on the

LAN shall be programmable to respond to the peak demand information from its respective meter.

15.07 SLIDING WINDOW

A. The demand control function shall utilize a sliding window method with the operator being able to establish the kilowatt threshold for a minimum of three adjustable demand levels. The sliding window interval shall be operator selectable in increments of one minute, up to 60 minutes.

B. Systems that incorporate rotating shed tables shall not be acceptable.

15.08 SETPOINTS FOR DEFINED DEMAND LEVEL

A. The operator shall have the capability to set the individual equipment temperature setpoints for each operator defined demand level. Equipment shall not be shed if these reset setpoints are not satisfied; rather the setpoint shall be revised for the different established demand levels. The system shall have failed meter protection, such that when a KW pulse is not received from the utility within an operator adjustable time period, an alarm will be generated. The system software will automatically default to a predetermined fail-safe shed level.

15.09 INFORMATION ARCHIVING

A. The system shall have the ability to archive demand and usage information for use at a later time. System shall permit the operator access to this information on a current day, month to date and a year to date basis.

15.10 DAY/NIGHT SETBACK (DNS)

A. The system shall allow the space temperature to drift down [up] within a preset [adjustable] unoccupied temperature range. The heating [cooling] shall be activated upon reaching either end of the DNS range and shall remain activated until the space temperature returns to the DNS range.

15.11 OUTSIDE & EXHAUST AIR

A. The system shall be capable of closing all outside air and exhaust air dampers during the unoccupied period, except for 100% outside air units.

15.12 UNOCCUPIED SPACE TEMPERATURE

A. Unoccupied space temperature shall be monitored by the DDC temperature sensors located in the individual zones being controlled or within a representative room.

15.13 PARAMETER CHANGES

A. Operator shall be able to define, modify or delete any of the following parameters. DNS setpoint temperature(s)

B. Temperature band for night heating operation Period when the DNS is to be activated

15.14 TIMED LOCAL OVERRIDE (TLO)

A. The system shall have TLO input points that permit the occupants to request an override of equipment that has been scheduled OFF. The system shall turn the equipment ON upon receiving a request from the local input device. Local input devices shall be push button (momentary contact), wind-up timer, or ON/OFF switches as detailed in the I/O summary.

15.15 EQUIPMENT 'ON' TIME

A. If a push button is used the system operator shall be able to define the duration of equipment ON time per input pulse and the total maximum ON time permitted. The input point will cancel override time already entered. If a wind-up timer is used the equipment will stay in override mode until the timer expires. Year to date, month-to-date and current day override history shall be maintained for each TLO input point. History data shall be accessible by the operator at any time and shall be capable of being automatically stored on hard disk and/or printed on a daily basis.

15.16 SPACE TEMPERATURE CONTROL (STC)

A. There shall be two (2) space temperature setpoints, one for cooling and one for heating, separated by a dead band. Only one (1) of the two (2) setpoints shall be operative at any time.

B. The cooling setpoint shall be operative if the actual space temperature has more recently been equal to or greater than the cooling setpoint.

C. The heating setpoint shall be operative if the actual space temperature has more recently been equal to or less than the heating setpoint.

15.17 OCCUPANCY-BASED TEMPERATURE CONTROL

A. Occupancy-based modes of space temperature control each have separate set points as follow: 'occupied' mode :
   1. heating = 72 deg F (22 deg C), cooling = 76 deg F (24.4 deg C) 'unoccupied' mode :
   2. heating = 55 deg F (12.7 deg C), cooling = 90 deg F (32 deg C).

15.18 SCHEDULE

A. The occupied/unoccupied modes may be scheduled by time, date, or day of week.

15.19 COLOR CODE

A. One of five colors shall be generated to represent the comfort conditions in the space, and shall be displayed graphically at the operator station under the following conditions:
   1. If the actual space temperature is in the dead band between the heating setpoint and the cooling setpoint, the color displayed shall be green, representing ideal comfort conditions.
   2. If the space temperature rises above the cooling setpoint, the color shall change to orange. Upon further rise beyond the orange band offset, the color shall change to red indicating unacceptable high temperature conditions. At this point an alarm shall be generated to notify the operator.
   3. When space temperature falls below the heating setpoint, the color shall change to blue. Upon further temperature decrease blue band offset minus the dark blue band offset the color shall change to red indicating unacceptable low temperature conditions. At this point an alarm shall be generated to notify the operator.

15.20 SETPOINTS AND OFFSETS

A. All setpoints and offsets shall be operator-definable.

15.21 ADDITIONAL COOLING

A. When comfort conditions are warmer than ideal, indicated by the color orange, and high temperature red, a request for additional cooling shall be sent over the network to other cooling equipment in the HVAC chain, such as a chiller. This information is to be used for optimization of equipment in the HVAC chain. The operator shall be able to disable this function if desired.

15.22 ADDITIONAL HEATING

A. When comfort conditions are cooler than ideal; indicated by the color blue, and low temperature red; a request for additional heating shall be sent over the network to other heating equipment in the HVAC chain, such as a boiler. This information is to be used for optimization of equipment in the HVAC chain. The operator shall be able to disable this function if desired.

15.23 OPTIMUM START

A. An optimum start-up program transitions from the unoccupied setpoints to the occupied setpoints. The optimum start-up algorithm considers the rate of space temperature increase required to meet scheduled heating set points and the rate of space temperature decrease required to meet scheduled cooling set points under nominal outdoor-temperature

conditions. Optimum Start also considers the outdoor temperature and the heat loss or gain coefficients of the building envelope (AI: Space Temperature).

15.24 PID LOOP.

A. A PID control loop, comparing the actual space temperature to its setpoint, shall modulate the dampers [and heating coil valve or heating stages in sequence] to achieve the setpoint target.

PART 16 HVAC SEQUENCES OF OPERATION

16.01 MECHANICAL BAS CONTROLS - GENERAL

A. Reference Drawing for Sequences of Operation

B. Temperature settings should be set at the following temperatures with adjustable +/- two (2) degrees:

Cooling:

a. 74˚- 76˚ (Occupied) and 81˚ - 83˚ (unoccupied)

2. Heating:

a. 68˚- 70˚ (Occupied) and 60˚ - 62˚ (unoccupied)

PART 17 CONSTRUCTION/INSTALLATION REQUIREMENTS

A. Harris County requires a Single-Source Responsibility of Contract: One contractor shall be responsible for obtaining all hardware and software. The single-source contractor shall be responsible for the complete design, installation, and commissioning of the system.

B. The controls contractor shall be in the business of design, installation and service of such building automation control systems similar in size and complexity.

C. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in production and installation of HVAC control systems. Products should be manufacturer’s latest standard design and have been tested and proven in actual use.

D. The controls contractor shall provide a list of no fewer than five (5) similar projects which have building control systems as required by the current project. These reference projects must currently be on-line and functional such that the County Representative would observe the control systems in full operation, if the County selects this option.

E. The controls subcontractor shall have in-place a facility within fifty (50) miles of the project location, with technical staff, spare-parts inventory/availability for the next five (5) years, and necessary test and diagnostic equipment to support, service and repair the project's control system(s).

F. The controls contractor shall have minimum of five (5) years of experience in design and installation of building automation systems similar in performance to the project. Provide evidence of experience by submitting resumes of the Project Manager/Representative, the local branch manager, project engineer, the application engineering staff, and the electronic technicians who would be involved with the supervision, the engineering, and the installation of the control systems. Training and experience of these personnel should not be less than three (3) years. Failure to disclose this information will be a ground for disqualification of the supplier.

G. Provide a competent and experienced Project Manager/Representative employed by the Controls Contractor. The Project Manager/Representative shall be supported as necessary by other Contractor employees in order to provide professional engineering, technical and management service for the work. The Project Manager/Representative shall attend scheduled Project Meetings as required and shall be empowered to make technical, scheduling and related decisions on behalf of the Controls Contractor.

PART 18 MECHANICAL DRAWINGS

A. The Mechanical drawings must show system control schematics for the sequence of operation for each HVAC system. The drawings must also show controller functions, such as: normally open (NO), normally closed (NC), common (C), etc. Indicate all set points. Describe all controlled equipment operating modes, sequence of events, set points, and alarms.

B. Controls air flow diagrams, indicating air handler configuration and equipment arrangement shall be provided with location of all control devices shown. Dampers and control valves shall have their normal (fail) position indicated on the diagram. These diagrams will be used by the controls contractor to develop the system graphics.

C. Chilled water and hot water piping controls diagrams, indicating pump and equipment configuration, should be provided with location of all control devices shown. Control valves shall have their normal (fail) position indicated on the diagram.

D. A complete controls input/output points list shall be provided on the drawings and a system architecture schematic.

E. A detailed sequence of operation shall be provided on the drawings, on the same sheet as the diagram for each system, and must include the following:

F. Provide AHU system description, including all components such as supply fans, return or relief fans, coils, dampers, filter sections and terminal devices.

G. Provide pumping system description, including all components such as pumps, heat exchangers, control valves, and bypass valves.

H. Provide normal start-up sequence for each system and start-up sequence after power failure restoration. State normal position of all control dampers and valves when system commanded OFF and when system trips off due to safety or power failure. Detail equipment system response for each potential equipment alarm and failure.

I. Indicate percent of full load that pumps/fans are sized and if they operate in lead/lag or both operate simultaneously.

J. Provide economizer cycle sequence when applicable. Detail all alarms, alarm limits, and identify critical alarms.

K. List initial settings for all operator modifiable control parameters, such as, but not limited to, set-point, dead-band, offset, and equipment start/restart delay.

L. Mechanical drawings must show temperature sensor locations for all terminal boxes with dashed line from each sensor to respective VAV box. Show dashed line at each VAV to indicate 3 feet maintenance access required for controls. Locate VAV’s so that maintenance access area is not above fixed furniture or lab casework, preferably above door entry for the room.

M. Drawings must show location of VFDs and control cabinets on mechanical plan. Provide VFD schedule for pumps and fans.

END OF SECTION

SECTION 260500
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. Section Includes:
   1. Summary of Work.
   2. Submittals, Analysis and Device Schedules.
   3. Record Documents.
   4. Operating and Maintenance Manuals.
   5. General Electrical Product Requirements.
   6. General Electrical Installation Requirements.
   7. Electrical equipment coordination and installation.
   8. Sleeves for raceways and cables.
   9. Sleeve seals.
   10. Grout.
   11. Common electrical installation requirements.

B. Provide all work required for complete electrical and ancillary system as indicated on the drawings and in these specifications. This may include, but is not necessarily limited to; panelboards, transformers, cabinets, motor controllers, circuit breakers, fuses, disconnect switches, surge suppression, fire alarm system, Lighting Control System, interior and exterior lighting, parking lot lighting, lamps, relay panels, contactors, controls, wiring devices, wire and cable, grounding and bonding, lightning protection, equipment wiring system, conduit, raceways, boxes, supporting devices, identification, fire stopping, testing, excavating, concrete equipment bases, concrete duct encasements, conduit sleeves and supports, anchors, vibration and sound isolation, access panels, record drawings, installation permits, inspections by governing authorities, electrical work of certain temporary facilities and services, cutting-and-patching work, utility connection coordination, start-up of electrical systems and equipment, training of Owner's operating personnel, operating and maintenance manuals, final cleaning of electrical and similar work.

C. Except where otherwise indicated, electrical drawings prepared by Engineer (contract drawings) are diagrammatic in nature and may not show locations accurately for various components of electrical systems. It is the intention of the Construction Documents to establish the types and functions of the systems, but not to set forth each and every item essential to the functioning of any system. The Contractor shall make necessary changes or additions as may be reasonably inferred from the construction documents for a complete operating system as required and record these on the record documents at no cost to the Owner.

D. Contractor shall visit site prior to submitting his proposal and become familiar with the conditions under which the Work is to be performed, and correlate site observations with the requirements of the Contract Documents. Errors, inconsistencies, or omissions discovered shall be reported to the Architect/Engineer at once.

E. All electrical products and installations shall comply with the latest additions of the following standards where applicable:

1. ADA - AMERICANS WITH DISABILITIES ACT
2. ANSI - AMERICAN NATIONAL STANDARDS INSTITUTE
3. ASTM - AMERICAN SOCIETY FOR TESTING AND MATERIALS
4. CBM - CERTIFIED BALLAST MANUFACTURERS
5. ETL - ELECTRICAL TESTING LABORATORIES
6. FM - FACTORY MUTUAL
7. ICEA - INSULATED CABLE ENGINEERS ASSOCIATION
8. IEEE - INSTITUTE OF ELECTRONICS AND ELECTRICAL ENGINEERS
9. NEC - NATIONAL ELECTRICAL CODE
10. NECA - NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION
11. NEMA - NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
12. NESC - NATIONAL ELECTRICAL SAFETY CODES
13. NFPA - NATIONAL FIRE PROTECTION ASSOCIATION
14. NETA - INTERNATIONAL ELECTRICAL TESTING ASSOCIATION
15. OSHA - OCCUPATIONAL SAFETY AND HEALTH ASSOCIATION
16. UBC - UNIFORM BUILDING CODE
17. IBC – INTERNATIONAL BUILDING CODE
18. ICC – INTERNATIONAL CODE COUNCIL
19. IECC – INTERNATIONAL ENERGY CONSERVATION CODE
20. ISO – INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
21. UL - UNDERWRITERS LABORATORIES, INC.
22. STATE ENERGY CONSERVATION CODE
23. MUNICIPAL OR COUNTY CODES. IN THE EVENT OF CONFLICTS BETWEEN CODES OR STANDARDS, THE MORE STRINGENT REQUIREMENTS SHALL GOVERN
24. All codes adopted by the local jurisdiction having authority.

F. All work and materials shall be warranted as indicated in Division 1.

G. Contractor is responsible for filing and paying for all fees and obtaining necessary permits and certificates of inspection, and shall deliver all certificates of inspection to Owner, and include copies with maintenance manuals.

1.04 SUBMITTALS

A. General Submittal Requirements:
1. All submittals shall be in accordance with Division 1 requirements.
2. Submit number of copies indicated in Division 1 or 6 copies, whichever is greater.
3. Applicability: Wherever it is indicated that shop drawings, samples, manufacturer's brochure, certification, test, copy of standard operating instructions, manual, extra stock, or warranty is required, appropriate submittal is required regardless of whether it is specified as "submittal"; Engineer's decision shall be final.
4. Do not purchase equipment until submittals have been reviewed by Engineer with no exceptions taken.
5. Signed Commitments: Do not proceed with transfer of electrical systems to Owner for operation until warranties, performance certifications, maintenance agreements and similar commitments to be signed by Contractor and other entities have been executed and transmitted to Engineer (for Owner's records).
6. Response to Submittals: Where standard product data have been submitted in fulfillment of project requirements, it is recognized that submitter has already determined that products fulfill specified requirements, and that submittals are for engineer's information only, but will be returned without action where observed to be non-complying with requirements. Where uniquely prepared information is submitted, it is recognized to represent preparer's interpretation or solution to specified requirements, subject to Engineer's concurrence and appropriate action as indicated in Division 1.

7. Submittals shall be signed by the General Contractor and Subcontractor responsible for this work.
8. The Engineer's review of submittals is solely for general conformance with the design concept. The Engineer's review does not relieve the Contractor from total responsibility for quantities, errors, omissions, or compliance with the intent of the original contract documents. Review and approval by the Contractor is required before fabrication, shipment or installation.

B. Substitutions: Electrical submittals are not opportunities for gaining acceptance of substitutions. Any variance from the contract documents shall be identified in accordance with Division 1 requirements. Substitutions will be reviewed only for those reason identified in Division 1 and only if the procedures identified in Division 1 are followed. Any variances from the contract documents in the submittals which are not identified by the Contractor in accordance with the procedures of Division 1 and subsequently not identified by the Engineer's review shall be corrected by the Contractor at no cost to the Owner. Substitution request would only be considered if product is equal or better than what listed.

C. By submitting shop drawings on the project, this contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other trades. Submittals for each group will be returned without review unless all sections are included. Sections will not be reviewed separately. At the Engineer's discretion, when a re-submittal is required for one section, any other sections within each group may require re-submittal. Contractor shall expedite submittals and re-submittals as required to allow for the Engineer's review time specified in Division 1. The groups of equipment shall be divided as follows:
   1. Raceways, Conductors and Miscellaneous Equipment
      a. Fire stopping
      b. Conduit
      c. Raceways, Multioutlet Assemblies, Wireways and Auxiliary Gutters
      d. Wires and Cables
      e. Outlet Boxes
      f. Wiring Devices
      g. Cabinets and Enclosures
      h. Grounding and Bonding
      i. Supporting Devices
      j. Electrical Identification
   2. Distribution Equipment
      a. Distribution Panelboards
      b. Enclosed Switches
      c. Dry Type Transformers
      d. Branch Circuit Panelboards
      e. Enclosed Motor Controllers
      f. Electrical Controls
   3. Lighting Fixtures
      a. Interior and Building Lighting Fixtures
   4. Specialty Systems
      a. Transient Voltage Surge Suppression (Surge Protective Devices)
      b. Fire Alarm System
   5. Testing
      a. Field Electrical Testing

D. Shop Drawings: Prepare electrical shop drawings to accurate scale except where diagrammatic representations are specifically indicated. Show clearance dimensions of critical locations and show dimensions of spaces required for operation and maintenance of equipment. Show

conduit layouts and wire/cable connections and other electrical service connections and show interfaces with other work, including structural support. Indicate by note, portions of electrical work shown on shop drawings which deviates from indication of work in contract documents and explain reasons for deviations. Show how such deviations coordinate with interfacing deviations on shop drawings for other portions of work, currently or previously submitted. Show wiring diagrams, erection, setting, weights, capacities, speeds, outputs, consumption, efficiencies, voltages, amperages, hertz, phases, noise levels, etc.

E. Samples: Engineer's review of required sample submittals will be limited to observation of general type, pattern, and finish; and will not include testing and inspection of submitted samples, except for those specifically indicated for that purpose in the contract documents. Compliance with specified requirements remains the exclusive responsibility of the Contractor.

F. Manufacturer's Data: Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which variations are to be provided. Delete or mark-out all portions or pre-printed data which are not applicable. Where operating ranges are shown, mark data to show portions of range required for project application. Expansion or elaboration of standard data to describe non-standard product must be processed as shop drawing data to describe non-standard product. For each product include manufacturer's production specifications, installation or fabrication instructions, nearest source of supply (including telephone number), sizes, weights, speeds, operating characteristics, ratings, conduit and wire/cable connection sizes and locations, statements of compliance with required standard and governing regulations (include manufacturer's signed statements if not covered in printed data), performance data (where applicable) and similar information needed to confirm compliance with requirements.

G. Manufacturer's Certification: Each manufacturer is required to review the system design as related to the proper operation of his equipment, including electrical requirements, automatic controls, mechanical systems and equipment locations and related items. With shop drawings submit a letter from the manufacturer stating that his equipment will operate satisfactorily under the design conditions. The manufacturer's representative shall review the final installation at the site and submit a second letter stating that the equipment operates satisfactorily as installed. Furnish certification for the systems listed in each section of Division 16.

H. Test Reports: The contractor for various sub-system shall submit proposed testing procedure for their system, subject to review and approval and owner acceptance. The contract will not be declared to be substantially complete until the functional operation of the subsystems have been demonstrated and verified and reports have been provided, reviewed and accepted. The project will not be declared substantially complete until the following has taken place:
   1. The “As-Built” drawings have been submitted, reviewed, and accepted by owner.
   2. The various systems have been commissioned and accepted. This will include the following systems:
      a. Building Fire Alarm System
      b. Building Computer Network
      c. Surveillance and Security System
      d. Intercom/Telephone
      e. Submit test report signed and dated by firms performing test, and prepare in manner specified in standard or regulation governing test procedure as indicated. Provide notarized executions on test reports.

I. Warranties: Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. A minimum of one-year warranty period is required for all materials and equipment. Warranty period starts upon first beneficial use or acceptance by OWNER whichever comes first.
   1. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; names,

addresses and telephone numbers and procedures for filing a claim and obtaining warranty services.

2. Where pre-printed and published warranty includes substantial deviation from required warranty (as judged by Engineer), product is automatically disqualified from use on project, except where manufacturer prepares and issues specific project, warranty on product, stating that it is in lieu of published warranty, and is executed by authorized officer, and complies with requirements.

J. Load Current and Overload Relay Heater List: Compiled by Contractor after motors have been installed. Arrange to demonstrate selection of heaters to suit actual motor nameplate full load currents.

1.05 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, indicate installed conditions for:
   1. Major raceway systems, size, and location for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; access panels; and fuse and circuit breaker size and arrangements.
   2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
   3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
   4. Underground cabling and conduits both interior and exterior, drawn to scale and fully dimensioned.
   5. Work concealed behind or within other work, in a non-accessible arrangement.
   6. Mains and branches of wiring/cabling systems, with switchboards, panelboards, and control equipment and devices located and numbered with terminals and connections located, and with equipment requiring maintenance located.
   7. Grounding systems including primary, secondary and special.

B. Execution: Each installer or other entity responsible for recording installed work shall record firm name, signature and date on each drawing so marked.

C. Prior to transmittal of corrected drawings, obtain three (3) sets of blue-line prints of each drawing in each set, regardless of whether corrections were necessary, and include in transmittal (two (2) sets are for Owner's use, and one (1) is for Engineer's records).

1.06 OPERATING AND MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1. In addition to the requirements specified in Division 1, provide the following.

B. Submit sets prior to final inspection, in 8½ x 11-inch text pages, bound in style D, three ring binders with durable plastic covers.

C. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS, ELECTRICAL", and title of project.

D. Internally sub-divide the binder contents with permanent page dividers, logically organized, with tab titling clearly printed under reinforced laminated plastic tabs.

E. Contents:
   1. Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractor, and major equipment suppliers.
   2. Operation and maintenance instructions, arranged by system.
   3. Project documents and certificates.
   4. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

5. Manufacturer's original printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions. (Copies are not acceptable).
6. Maintenance procedures for routine preventative maintenance and troubleshoot; disassembly, repair, and re-assembly; aligning and adjusting instructions.
7. Servicing instructions and lubrication charts and schedules.
8. Warranty information including any corrections made during submittals.
9. Replacement parts list.
10. List of tools and accessories needed for maintenance

1.07 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 PRODUCTS

2.01 GENERAL MANUFACTURER QUALIFICATION:

A. Production Experience: For all electrical equipment, manufacturer shall be firm with not less than five (5) years successful production experience. Experience means production of units similar to those required, as judged by Engineer. Comply with longer-period experience requirements specified in other Division 16 sections of these specifications. Product shall be new and design for quiet, vibration free operation.

2.02 GENERAL ELECTRICAL PRODUCT REQUIREMENTS:

A. Standard Products: Provide not less (quality) than manufacturer's standard products as specified by published product data. Do not assume that available off-the-shelf condition of product complies with requirements; as example, specific finish or color may be required.

B. Unencumbered Purchases: Avoid purchases and use of products which are encumbered with questionable title transfers, patent rights, trade union restrictions, code compliance, non-listings as "approved products" for compliance with governing regulations, duties due, embargoes and similar possible encumbrances, claims or sellers interest.
   1. Purchasing: Do not purchase specific electrical materials and equipment for project until completion of submittals.

C. Condition of Products: Except as otherwise indicated, provide new electrical products, free of defects and harmful deterioration at time of installation. Do not use units, which have been subjected to destructive testing, or other high-limits testing except where pre-tested products are specified. Comply with Division 1 requirements for exposure or visual display limitations against trademarks and manufacturer's names. Provide each product complete with trim,

accessories, finish, guards, safety devices and similar components specified or recognized as integral parts of products or required by governing regulations.

D. Assembly and Testing: To greatest extent possible and unless otherwise indicated, complete fabrication, assembly, finishing and testing of products prior to delivery to project. Notify Engineer not less than one week in advance of pre-installation testing to be performed in response to project requirements. Engineer reserves right to be present at tests of electrical products; however, neither their absence nor presence relieves the Contractor of responsibility for compliance with requirements.

E. Uniformity: Where multiple units of generic product are required for single major system of electrical work, e.g., cable trays, lighting systems, provide identical products by same manufacturer, without variations.
   1. Limitations: Product/manufacturer uniformity does not apply to conduit and fittings, 600V electrical wire, sheet metal, steel bar stock, welding rods, solder, factory applied paint between different systems, fasteners, motors for unalike equipment units, and similar items used in work, and except as otherwise indicated.

F. Product Compatibility, Options: Where more than one product selection is specified, selections are Purchaser's or Installer's options, except do not provide products which are not compatible with previously purchased or installed products which must interface with selections. Provide electrical adaptations as needed for interfacing of selected products in work.

G. Quality Assurance: Provide products listed by and installed in accordance with all references in each section under quality assurance any other applicable requirements.

H. Elevation Requirements: Electrical equipment provided shall perform at mean elevation of 1000 feet (30480 cm) above sea level.

2.03 SLEEVES FOR RACEWAYS AND CABLES

A. Retain one of first two paragraphs below for penetrations through exterior walls above and below grade.

B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

C. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

D. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (406.4 mm), thickness shall be 0.052 inch (1.32 mm).
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (406.4 mm), thickness shall be 0.138 inch (3.51 mm).

2.04 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

2.05 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 EXECUTION

3.01 GENERAL ELECTRICAL INSTALLATIONS

A. The contractor shall provide all necessary items for a complete operating system.

B. Provide all electrical systems required by and in accordance with Division 26.

C. Perform work for other divisions as required for electrical installations, or coordinate such work with other trades which includes but is not necessarily limited to:
   1. Division 01: Submittal Procedures, Temporary Facilities and Controls, Cutting and Patching, Closeout Procedures, Project Record Documents, General Commissioning Requirements, etc.
   2. Division 02: Demolition, etc.
   3. Division 03: Cast-in-place Concrete.
   4. Division 05: Metal Fabrications.
   5. Division 06: Rough Carpentry.
   6. Division 07: Penetration Firestopping and Joint Sealants.
   7. Division 08: Access Doors and Frames
      a. Deviation: Contractor is encouraged to coordinate and combine electrical access with mechanical access and has the option to not add electrical access panels if acceptable coordination can be achieved.
   8. Division 09: Painting: In addition to Division 09, paint electrical equipment factory applied paint surfaces damaged during installation with paint purchased from equipment manufacturer to match each damaged surface.
   9. Division 21: Heat Tracing for Fire-Suppression Piping and Electric Drive Fire Pumps
   10. Division 22: Heat Tracing for Plumbing Piping and Drinking Fountains and Water Coolers
   11. Division 23: HVAC and Plumbing motors, controls, accessories, and connections.
   12. Division 27: Communications.
   13. Division 28: Electronic Safety and Security.
   14. Division 31: Earth Moving.

D. Verify all dimensions by field measurements.

E. Arrange for chases, sleeve, slots, and openings in other building components during progress of construction, to allow for electrical installations.

F. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

G. Where mounting heights or locations are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom and working clearances possible, but not less than required by Code.

H. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings and manufacturer's instructions, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

I. Install systems, materials, and equipment level and plumb, parallel, and perpendicular to other building systems and components, where installed exposed in finished spaces.

J. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

K. Install J-boxes for all other equipment requiring access or maintenance, which are concealed behind surfaces so that these devices can be serviced from the access panels. Where practical, group J-boxes and equipment so that they can be accessed from the same panel or door. If additional panels are needed, panels must be submitted for approval.

L. Cut, remove, and legally dispose of selected electrical equipment, components, and materials, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new work.

M. The A/E reserves the right to make relocations up to 6 feet (182.88 cm) of outlets, boxes, cabinets, lighting, etc. before finished rough-in at no cost to the Owner.

N. Contractor shall notify design prime consultant and associated owner representative when he requests an inspection by the City Inspector.

3.02 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. All buried conduit and pipe extending past the building footprint shall have a 12-gauge tracer wire, stubbed up above ground so the tracer can connect to it. Or, the contractor shall bury a continuous, brightly colored plastic ribbon cable marker with each underground cable or conduit. The ribbon shall be located directly over the cables, at least six (6) inches below finished grade.

G. Low voltage and control circuit conductors shall be piped separately from the supply conductors.

H. All electrical conductors shall be run in a raceway, cable tray, or conduit. Conductors shall not be run on bridle rings or hooks.

3.03 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50.8 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable

penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.04 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.05 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protection and Identification: Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identification; adequately packaged or protected to prevent deterioration during shipment, storage and handling. Store in dry, well ventilated, indoor space, except where prepared and protected by manufacturer specifically for exterior storage.

3.07 TEMPORARY WIRING

A. The electrical contractor shall arrange for and provide all necessary equipment, outlets, temporary lights, metering and communications as required during the construction period for temporary electrical service to the project.

B. It shall be the responsibility of the electrical contractor to consult with all other trades on the project in order to determine the voltage of temporary electrical service required to operate the construction equipment to be employed and to provide such services to the project.

C. It shall be the responsibility of the electrical contractor to make all arrangements for, and to furnish and install, any and all temporary wiring, switches, and structures which may be required to maintain service continuity during the entire construction period. Temporary power and lights shall be UL listed and shall include a ground wire, a guard, and a proper means of support.

D. All temporary installations shall be performed in accordance with the current edition of the National Electrical Code. All machinery and equipment powered by electricity shall have effective electrical equipment grounding provided with all electrical circuits.

3.08 UTILITIES

A. This contractor shall examine the site and shall verify, to his own satisfaction, the location and elevation of all utilities, and shall adequately inform himself as to their relation to the work before entering into a contract.

B. Existing utility lines shown within the scope of this project to be abandoned or removed shall be performed as directed by the Owner, and/or utility companies.

C. Existing utility lines not shown on the drawings but encountered during construction shall be protected, relocated or capped as directed by the Owner, and/or utility companies. All precautions shall be exercised to prevent damage to existing lines not shown, but should work become necessary, it must be authorized prior to execution except in an emergency situation.

D. Before beginning excavations of any nature whatsoever, the contractor shall make an attempt to locate all underground utilities of every nature occurring within the bounds of the area to be excavated. The contractor shall then proceed with caution in his excavation work so that no utility shall be damaged with a resultant loss of service.

E. Should any damage result to any utility through the contractor's negligence or failure to comply with the above directive, he will be liable for such damage and for all expense incurred in the expeditious repair or replacement of such damaged utilities.

F. Repair of damaged utilities shall be to a condition equal to or better than the adjacent undamaged portion of such utility and to the complete satisfaction of the Owner and/or utility companies.

3.09 EXCAVATION

A. The contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated and/or required for the installation of all portions of the utilities systems. All excavated materials not required for fill or backfill shall be removed. All excavation shall be made by open cut. The banks of trenches shall be kept as nearly vertical as practicable and where required shall be properly shored and braced. Trenches shall be not less than 12" wider nor more than 16" wider than the outside diameter of the conduit, and shall be excavated true to line so that a clear space not less than 6" nor more that 8" in width is provided on each side of the conduit or duct bank.

B. Except at locations where excavations of rock from bottom of trenches is required, care shall be taken not to excavate below the depths indicated. Where rock excavation is required, the rock shall be excavated to a minimum over-depth of 4" below the trench depths indicated on the drawings or as specified. The over-depth rock excavation shall be backfilled with loose, moist earth and thoroughly tamped.

C. Whenever wet or otherwise unstable soil that is incapable of supporting the conduit duct bank, pole base or pad is encountered in the trench bottom, such soil shall be removed to a depth required. The trench bottom shall be filled with coarse sand, fine gravel, or other suitable material.

D. Backfill with earth under pole bases, pads or other buried structures will not be permitted, and any unauthorized excess excavation below the levels indicated for foundation of such structures shall be filled with sand, gravel or concrete at the expense of the contractor.

E. All grading in the vicinity of excavations shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or by other approved method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from the edges of trenches to avoid overloading and to prevent slides or cave-ins.

3.10 BACK-FILLING

A. Trenches shall not be back filled until all required tests are performed and until the utilities systems as installed conform to the requirements specified.

B. Trenches shall be carefully back filled with the excavated materials approved for back filling. This material shall consist of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials, free from large clods of earth or stones, deposited in thoroughly and carefully tamped 6" layers, until the conduit has a cover as specified. Broken rock, broken concrete or pavement, and large boulders shall not be used as backfill material.

C. Settling the backfill with water will be permissible and will be a requirement when so directed.

D. Any trenches across roadways or other areas to be paved shall be back filled with K-Crete or approved equal (ashes combined with concrete) in such manner as to permit the rolling and compaction of the filled trench. Together with the adjoining earth, shall provide required bearing value so that paving of the area can proceed immediately after the backfilling is completed.

3.11 CLOSEOUT PROCEDURES

A. General Coordination: Refer to Division 1 sections and individual specification sections for coordination of electrical closeout work with variable loads on electrical system. Coordinate taking of final photographs (if any) with electrical closeout, so that maximum detail of work as finally accepted is shown. Sequence closeout procedures properly, so that work will not be endangered or damaged, and so that every required performance with be fully tested and demonstrated.

B. System Performance Test Runs: Coordinate test runs of electrical systems with test runs of equipment served thereby (heating, air conditioning, plumbing, etc.). Check each item in each system to determine that it is set for proper operation. With Owner's Representative and Engineer present, operate each system in test run of appropriate duration to demonstrate compliance with performance requirements. During or following test runs, make final corrections or adjustments of systems to refine and improve performances where possible, including noise and vibration reductions, elimination of hazards, better response of controls, signals and alarms, and similar system performance improvements. Provide testing or inspection devices as may be reasonably requested for Engineer's observation of actual system performances. Demonstrate that controls and items requiring service or maintenance are accessible.

C. Cleaning and Lubrication: After final performance test run of each electrical system, clean system both externally and internally. Comply with manufacturer's instructions for lubrication of both power and hand-operated equipment and remove excess lubrication. Touch-up minor damage to factory-painted finishes and other painting specified as electrical work; refinish work where damage is extensive.

D. General Operating Instructions: In addition to specific training of Owner’s Maintenance and Operating personnel specified in individual Division 26 work sections, and in addition to preparation of written operating instructions and compiled maintenance manuals specified in Division-26 Sections and elsewhere in these specifications, provide general operating instructions for each operational system and equipment item of electrical work. Coordinate instructions with instructions for mechanical work, elevators and other equipment where associated with electrical systems or equipment.
   1. Describe each basic electrical system and functioning of its control system.
   2. Explain identification system, mimic diagrams, signals, actuators, sensors, alarms, telecommunication systems, and similar audio/visual provisions.
   3. Describe interfaces with mechanical equipment, including interlocks, sequencing, start-up, shut down, emergency, safety, system failure, security and similar provisions.
   4. Outline basic maintenance procedures and major equipment turnaround requirements, including adjustments to optimize output and efficiency of electrical system.
   5. Display and conduct "thumb-through" explanation of maintenance manuals, record drawings, spare parts inventory, storage of extra materials, meter readings and similar service items.

E. Construction Equipment: After completion of performance testing and Owner's operating instructions and demonstrations, remove installer's tools, test facilities, construction equipment and similar devices and materials used in execution of work but not incorporated in work.

F. Security and Protection: During electrical work closeout phase, meet with Owner's operating representative frequently (daily where necessary) and agree upon status of operational responsibility for electrical systems (including securing provisions to prevent unauthorized

operations, and including protective measures to ensure that systems are not neglected or misused.

3.12 CONTINUED SYSTEM OPERATIONS

A. Acceptance and Continued Services: Coordinate Owner's take-over of electrical systems with take-over of mechanical systems, including the provision of skilled electrical operating and maintenance personnel until time Owner's personnel take over operation of entire mechanical and electrical plant. Contractor shall continue consultation and services (beyond take-over date) for electrical systems, matching required continued services on associated mechanical systems and equipment.

END OF SECTION

SECTION 260519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

3.01 REFERENCE STANDARDS

A. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.

B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

C. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. UL 13 - Power-Limited Circuit Cables; Current Edition, Including All Revisions.

F. UL 1666 - Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts; Current Edition, Including All Revisions.

G. UL 1685 - Standard for Safety Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables; Current Edition, Including All Revisions.

3.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

3.03 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600V and less.
   2. Connectors, splices, and terminations rated 600V and less.
   3. Sleeves and sleeve seals for cables.

B. Related Sections include the following:
   1. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

3.04 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Coordinate paragraph below with qualification requirements in Division 01 Section "Quality Requirements "Division 1 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.

C. Qualification Data: For testing agency.

D. Retain paragraph below if Contractor is responsible for field quality-control testing.

E. Field quality-control test reports.

3.05 QUALITY ASSURANCE

A. Retain first paragraph and subparagraph below if Contractor is required to provide services of an independent testing agency in Part 3 "Field Quality Control" Article. Qualification requirements supplement those specified in Division 01 Section "Quality Requirements, "Division 1 Section "Quality Requirements," which also includes the definition for NRTL (nationally recognized testing laboratory).

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

E. UL Compliance: Provide components which are listed and labeled by UL under the following standards.
   1. UL Std. 83 - Thermoplastic-Insulated Wires and Cables.
   2. UL Std. 4 - Armored Cable
   3. UL Std. 1569 - Metal-Clad Cables
   4. UL Std. 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   5. UL 13 - Power limited circuit cables.
   6. UL 1666 - Test for flame propagation height of electrical and optical-fiber cables installed vertically in shafts.
   7. UL 910 - Test for flame propagation and smoke density values for and optical fiber cables used in spaces environmental air.
   8. UL 1685 - Vertical tray fire propagation and smoke release test for and optical fiber cables.

F. NEMA WC-5: Thermoplastic-insulated wire and cable for the transmission and distribution of electrical energy.

G. Federal Specifications
   1. J-C-30B(1) cable and wire, electrical (power, fixed installation).

3.06 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 PRODUCTS

4.01 CONDUCTORS AND CABLES

A. All conductors and grounding electrode conductors shall be stranded copper.

B. Manufacturers of 600 V or less: Subject to compliance with requirements, provide products by one of the following:
   1. Southwire.
   2. Essex.
   3. General Wire.
   4. Owner and Engineer approved equal.

C. Copper Conductors: Comply with NEMA WC 70.

D. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN/THWN-2, XHHW-2, UF, USE and SO, fully colored for phase identification along complete length of wire.
   1. All conductor insulation to be fully colored required phase-identification color.

E. Multi-conductor Cable: Comply with NEMA WC 70 metal clad cable, Type MC, THHN/THWN-2 dual-rated insulation rated 90°C.

4.02 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Hubbell Power Systems, Inc.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division.
   5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

4.03 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

4.04 SLEEVE SEALS

A. Manufacturer: Subject to compliance with requirements, provide a comparable product by one of the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex Co.
   4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

PART 3 EXECUTION

5.01 CONDUCTOR MATERIAL APPLICATIONS

A. Copper. All stranded. No solid conductors.

B. The minimum wire/conductor size shall be AWG No. 12.

C. Neutral conductors may not be de-rated.

D. Type MC cable is only allowed for final whips to light fixtures.

5.02 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

G. All wire shall be installed in conduit or raceways.

H. All circuits shall have a hot, neutral and green ground wire unless otherwise indicated.

I. Provide #12 conductors and #12 ground minimum to all 15 and 20 amp devices unless otherwise indicated.

J. Provide #10 conductors and #10 ground minimum to all 30 amp devices unless otherwise indicated.

K. Provide #10 minimum conductors for 120/208V 20 amp circuits for which the distance from the panelboard to the to the first device is greater than 100 feet (3048 cm).

L. Provide #10 minimum conductors for 277/480V 20 amp circuits for which the distance from the panelboard to the to the first device is greater than 200 feet (6096 cm).

M. Do not install wires in conduit until entire system of conduit and outlet boxes is permanently in place.

N. Exercise care when installing wire in conduit to prevent injury to the conductor insulation. Mechanical means of pulling shall not be used unless approved. Conductors shall be pulled using UL non-flammable listed lubricant when necessary.

O. Whenever wiring leaves the conduit and terminates at a terminal board, the wiring shall be formed and laced with plastic wire ties.

P. In the event circuits feed through outlet boxes, provide splice and pigtail for device connection, with sufficient slack to pull splice out of box at least 6 inches (152.4 mm).

Q. Coordinate cable installation with other Work.

R. Pull conductors simultaneously where more than one is being installed in same raceway.

S. Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.

T. Keep conductor splices to a minimum.

U. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced.

V. Use splice and tap connectors which are compatible with conductor material.

W. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than no.10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.

X. Home Runs: except where specifically indicated, provide lighting branch circuit home runs with not more than three different line conductors and a common neutral in a single raceway for 4-wire, 3-phase systems.

Y. Conductors may be run inn parallel in sizes 1/0 through 750 MCM where indicated and provided that all conductors of each phase are the same length and so arranged and terminated as to ensure equal division of the current between all paralleled phase conductors.

Z. Feeders shall be installed in continuous pieces without splice.

AA. Install a separate neutral for each circuit which serves GFCI or isolated ground receptacles.

BB. Each circuit originating from a GFCI type circuit breaker shall also have a separate neutral.

CC. Where specifically indicated, for receptacle branch circuits, provide a separate neutral conductor for each line conductor.

DD. Each circuit serving receptacles where data terminals are used shall have separate neutral.

5.03 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Where allowed, make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
   1. Splices are prohibited in any distribution feeder and are only to be used for multioutlet branch circuits.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (152.4 mm) of slack.

5.04 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both wall surfaces.

F. Extend sleeves installed in floors 2 inches (50.8 mm) above finished floor level.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

J. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

K. Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Basis of design is LINK-SEAL by GPT Industries.

5.05 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

5.06 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Test Reports: Prepare a written report to record the following:
    1. Test procedures used.
    2. Test results that comply with requirements.
    3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

3.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

3.02 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

3.03 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

3.04 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

B. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).

C. MFMA-4 - Metal Framing Standards Publication; 2004.

D. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. SSPC-PA 1 - Shop, Field, and Maintenance Coating of Metals; 2024, with Errata (2025).

3.05 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

3.06 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.
   2. Nonmetallic slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.
   3. Nonmetallic slotted channel systems. Include Product Data for components.
   4. Equipment supports.

3.07 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

3.08 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 PRODUCTS

4.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. Thomas & Betts Corporation.
      e. Unistrut; Tyco International, Ltd.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   5. Channel Dimensions: Selected for applicable load criteria.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch diameter holes at a maximum of 8 inches (203.2 mm) o.c., in at least 1 surface.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. Fabco Plastics Wholesale Limited.
   2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
   3. Fitting and Accessory Materials: Same as channels and angles except metal items may be stainless steel.
   4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

1. Conduit straps shall be two-hole straps, fully covering perimeter of conduit. Do not use single-hole straps.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         3) MKT Fastening, LLC.
         4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
   2. Mechanical-Expansion Anchors: Insert-wedge-type, steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cooper B-Line, Inc.; a division of Cooper Industries.
         2) Empire Tool and Manufacturing Co., Inc.
         3) Hilti Inc.
         4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         5) MKT Fastening, LLC.
   3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   6. Toggle Bolts: All-steel springhead type.
   7. Hanger Rods: Threaded steel.

4.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 EXECUTION

5.01 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6.35 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

5.02 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (101.6 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
   6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

5.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

5.04 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (101.6 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

5.05 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.0508 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 260533
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
   1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.03 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquid-tight flexible metal conduit.

G. LFNC: Liquid-tight flexible nonmetallic conduit.

H. NBR: Acrylonitrile-butadiene rubber.

I. RNC: Rigid nonmetallic conduit.

J. RMC: Rigid metallic conduit:
   1. RAL: Rigid aluminum conduit.
   2. RGS: Rigid galvanized steel conduit.

K. PVC: Polyvinyl chloride.

L. FRP: Fiberglass reinforced polyester.

1.04 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2025.

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.

C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit - Aluminum (ERMC-A); 2025.

D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit; 2025.

E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

F. ISO 9000 - Quality Management — Fundamentals and Vocabulary; 2026.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

H. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

I. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013 (Reaffirmed 2020).

J. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; 2013 (Reaffirmed 2020).

K. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.

L. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.

M. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

N. SCTE 77 - Specifications for Underground Enclosure Integrity; 2023.

O. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

P. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

Q. UL 2024 - Standard for Cable Routing Assemblies and Communications Raceways; Current Edition, Including All Revisions.

1.05 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
   1. Custom enclosures and cabinets.
   2. For handholes and boxes for underground wiring, including the following:
      a. Duct entry provisions, including locations and duct sizes.
      b. Frame and cover design.
      c. Grounding details.
      d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
      e. Joint details.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Structural members in the paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Qualification Data: For professional engineer and testing agency.

E. Source quality-control test reports.

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 PRODUCTS

2.01 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Alflex Inc.
   3. Allied Tube & Conduit; a Tyco International Ltd. Co.
   4. Anamet Electrical, Inc.; Anaconda Metal Hose.
   5. Electri-Flex Co.
   6. Manhattan/CDT/Cole-Flex.
   7. Maverick Tube Corporation.
   8. O-Z Gedney; a unit of General Signal.

9. Wheatland Tube Company.

B. RGS: ANSI C80.1.

C. RAL: ANSI C80.5.

D. IMC: ANSI C80.6.

E. EMT: ANSI C80.3.

F. FMC: Zinc-coated steel or aluminum.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
   2. Fittings for EMT: compression type.

I. Joint Compound for RGS or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.02 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Anamet Electrical, Inc.; Anaconda Metal Hose.
   3. Arnco Corporation.
   4. CANTEX Inc.
   5. CertainTeed Corp.; Pipe & Plastics Group.
   6. Condux International, Inc.
   7. ElecSYS, Inc.
   8. Electri-Flex Co.
   9. Lamson & Sessions; Carlon Electrical Products.
   10. Manhattan/CDT/Cole-Flex.
   11. RACO; a Hubbell Company.
   12. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

D. LFNC: UL 1660.

E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: UL 514B.

2.03 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Arnco Corporation.
   2. Endot Industries Inc.
   3. IPEX Inc.
   4. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible type, approved for general-use installation.

2.04 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, 12, 3R, unless otherwise indicated.

C. Fittings and Accessories: All fittings shall be steel – NOT cast aluminum. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type.

E. Finish: Manufacturer's standard enamel finish.

2.05 NONMETALLIC WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hoffman.
2. Lamson & Sessions; Carlon Electrical Products.

B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.06 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
14. Raychem is acceptable manufacturer for J-boxes

B. Electrical “J” box covers shall be marked with the panel name and number, the circuit (s) number (s), and the potential voltage. Example: Panel XX XX Circuits 1, 2 and 5 120 / 208v. Panel number shall list H, E, or L.

C. Telephone “J” box covers shall be marked with a triangle and the telephone room number in which it originates.

D. Data “J” box covers shall be marked with the word DATA and the data or computer room number in which it originates. Example: DATA Room XX XX

E. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

F. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.

G. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

H. Metal Floor Boxes: Cast or sheet metal rectangular.

I. Nonmetallic Floor Boxes: Nonadjustable, round.

J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

K. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

L. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Nonmetallic Enclosures: Plastic.

M. Cabinets:
   1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.

2.07 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.
   1. Color of Frame and Cover: Green.
   2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
   3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   5. Cover Legend: Molded lettering, "ELECTRIC." as indicated for each service.
   6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   7. Handholes 12 inches (304.8 mm) wide by 24 inches (609.6 mm) long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
   8. AASHTO M306-10 (2019) HS-25 rating required for all ground boxes.

B. All ground boxes shall be concrete with cast iron tops that are no higher than 1” above the finished grade with a gradual slope. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
   1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Armorcast Products Company.
      b. Carson Industries LLC.
      c. CDR Systems Corporation.
      d. NewBasis.
      e. Hubbell
      f. Engineer approved equal.

2.08 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.09 SLEEVE SEALS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex Co.
   4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
   1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   2. Pressure Plates: Plastic. Include two for each sealing element.
   3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.10 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Tests of materials shall be performed by a independent testing agency.
   2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 EXECUTION

3.01 RACEWAY APPLICATION

A. Outdoors: All exterior raceways shall be rigid galvanized steel. IMC, EMT, or Rigid Non-Metallic Tubing will be considered on a case-by-case basis. Apply raceway products as specified below, unless otherwise indicated:
   1. Aboveground Conduit: RMC.
   2. Underground Conduit: RNC, Type EPC-40-PVC, direct buried, unless otherwise noted.
   3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
   5. Application of Handholes and Boxes for Underground Wiring:
      a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
      b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.

c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed in Specific Areas: RMC or IMC. Includes raceways in the following locations:
a. Mechanical rooms.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: RMC or IMC.
6. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: IMC.
7. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: IMC.
8. Raceways for Concealed General-Purpose Distribution of Optical Fiber or Communications Cable: EMT.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size:
1. Generally: 3/4-inch trade size.
2. Preterminated Cables: 1-1/2-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

E. Do not install aluminum conduits in contact with concrete.

F. Spare conduit of no less than (1) 3/4” and (1) 1” shall be provided on all sides of new buildings, under drives and sidewalks, from outside to inside the building, between parking lots and medians, and at light pole standards for future Owner and Vendor use.

G. Large areas (greater than 15 feet (457.2 cm) wide) with gypsum board ceilings shall have minimum of 3 conduits (2”) installed with pull strings for future wire pulls.

3.02 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches (152.4 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. J-boxes shall be permanently labeled with panel and circuit numbers. Panel number shall list H, E, or L.

E. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

F. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

G. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

H. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

I. PVC pipe is not permitted in return air plenums (environmental air handling spaces).

J. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull wire. They shall end in a covered “J” box. The cover shall be labeled with the SPARE designation and the panel name and number in which it originates. Example: SPARE Panel XX XX

N. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid, and flexible, as follows:
1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (1524 cm).
2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet (2286 cm).
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

O. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

P. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet (762 cm).
1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg F temperature change.
2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch (0.01 mm) per foot of length of straight run per deg F of temperature change.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

Q. Flexible Conduit Connections: Use maximum of 72 inches (1828.8 mm) of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

R. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

S. Set metal floor boxes level and flush with finished floor surface.

T. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.03 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches (152.4 mm) in nominal diameter.
   2. Install backfill as specified in Division 31 Section "Earth Moving."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (304.8 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
   4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
   5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
      a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (76.2 mm) of concrete.
      b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1524 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
   6. Warning Planks: Bury warning planks approximately 12 inches (304.8 mm) above direct-buried conduits, placing them 24 inches (609.6 mm) o.c. Align planks along the width and along the centerline of conduit.
   7. As an alternate, it shall be bid that all underground electrical service 110 volts or greater outside the paving or concrete slab shall be embedded in red concrete. The red concrete shall be two (2) inches thick on all sides. Red dye may not be applied to the top of the concrete. The base bid shall include a minimum of embedding all medium and high voltage circuits and larger duct banks in concrete.

3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25.4 mm) above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

F. It is preferred that buried J-box joints be made with heat shrink tape. Raychem #HVBT 2R, or Engineer approved equal is approved tape.

3.05 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (406.4 mm), thickness shall be 0.052 inch (1.32 mm).
   2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (406.4 mm), thickness shall be 0.138 inch (3.51 mm).

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches (50.8 mm) above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.06 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.07 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.08 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

3.01 REFERENCE STANDARDS

A. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.

B. 29 CFR 1910.145 - Accident Prevention Signs and Tags; Current Edition.

C. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.

D. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2023.

E. ASTM D638 - Standard Test Method for Tensile Properties of Plastics; 2022.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

H. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

3.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

3.03 SUMMARY

A. Section Includes:
   1. Identification for raceways.
   2. Identification of power and control cables.
   3. Identification for conductors.
   4. Underground-line warning tape.
   5. Warning labels and signs.
   6. Instruction signs.
   7. Equipment identification labels.
   8. Miscellaneous identification products.

3.04 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
   1. Include intended label for each Electrical equipment for review.

3.05 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

3.06 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

4.01 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:
   1. Black letters on an orange field.
   2. Legend: Indicate voltage and system or service type.

C. Colors for Raceways Carrying Circuits at More Than 600 V:
   1. Black letters on an orange field.
   2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high letters on 20-inch centers.

D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

E. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50.8 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

G. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch-wide black stripes on 10-inch centers diagonally over orange background that extends full length of raceway or duct and is 12 inches (304.8 mm) wide. Stop stripes at legends.

H. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (1.27 mm), with stamped legend, punched for use with self-locking cable tie fastener.

I. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
   2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

4.02 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:
   1. Black letters on an orange field.
   2. Legend: Indicate voltage and system or service type.

C. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high letters on 20-inch centers.

D. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

E. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50.8 mm) wide; compounded for outdoor use.

4.03 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (1.27 mm), with stamped legend, punched for use with self-locking cable tie fastener.

D. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

E. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50.8 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

4.04 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Insulation: Use fully-colored phase-identification insulation in lieu of “phase taping” for all sizes.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50.8 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

F. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

4.05 FLOOR MARKING TAPE

A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

4.06 UNDERGROUND-LINE WARNING TAPE

A. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.
   3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
   1. Comply with ANSI Z535.1 through ANSI Z535.5.
   2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
   3. Inscriptions for Orange-Colored Tapes: TELEPHONE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

4.07 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:
   1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal size, 7 by 10 inches (254 mm).

D. Warning label and sign shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

4.08 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (9.52 mm).

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (9.52 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (9.52 mm).

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (9.52 mm).

E. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25.4 mm).

4.09 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
   1. Minimum Width: 3/16 inch (4.76 mm).
   2. Tensile Strength at 73 deg F, According to ASTM D638: 12,000 psi (82737.12 kPa).

3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
1. Minimum Width: 3/16 inch (4.76 mm).
2. Tensile Strength at 73 deg F, According to ASTM D638: 12,000 psi (82737.12 kPa).
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
1. Minimum Width: 3/16 inch (4.76 mm).
2. Tensile Strength at 73 deg F, According to ASTM D638: 7000 psi (48263.32 kPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

4.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

5.01 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (203.2 mm) (below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches (406.4 mm) overall.

J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

5.02 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch- wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches (304.8 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:
   1. Floor surface directly above conduits running beneath and within 12 inches (304.8 mm) of a floor that is in contact with earth or is framed above unexcavated space.
   2. Wall surfaces directly external to raceways concealed within wall.
   3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot maximum intervals.

C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
   1. Emergency Power.
   2. Power.

D. Power-Circuit Conductor Identification, 600 V or Less: Use fully-colored insulation the entire length of the wire to identify the phase.
   1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
      a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
      b. Colors for 208Y/120 VAC Circuits:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
      c. Colors for 480Y/277 VAC Circuits:
         1) Phase A: Brown.
         2) Phase B: Purple.
         3) Phase C: Yellow.

E. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

F. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
   3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Limit use of underground-line warning tape to direct-buried cables.
   2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

I. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless

otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
   1. Comply with 29 CFR 1910.145.
   2. Identify system voltage with black letters on an orange background.
   3. Apply to exterior of door, cover, or other access.
   4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
      a. Power transfer switches.
      b. Controls with external control power connections.

K. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

L. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

M. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Labeling Instructions:
      a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches (50.8 mm) high.
      b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
      c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
      d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
   2. Equipment to Be Labeled:
      a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be laminated acrylic or melamine label.
      b. Enclosures and electrical cabinets.
      c. Access doors and panels for concealed electrical items.
      d. Switchboards.
      e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
      f. Substations.
      g. Emergency system boxes and enclosures.
      h. Motor-control centers.
      i. Enclosed switches.
      j. Enclosed circuit breakers.
      k. Enclosed controllers.
      l. Variable-speed controllers.
      m. Push-button stations.
      n. Power transfer equipment.

o. Contactors.
p. Remote-controlled switches, dimmer modules, and control devices.
q. Battery-inverter units.
r. Battery racks.
s. Power-generating units.
t. Monitoring and control equipment.

END OF SECTION

SECTION 261100
FIRE STOPPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Requirements of Division 16 "COMMON WORK RESULTS FOR ELECTRICAL" apply to this Section.

1.02 SECTION INCLUDES

A. Fireproof fire stopping materials.

1.03 REFERENCE STANDARDS

A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2026.

1.04 SUBMITTALS: SUBMIT THE FOLLOWING IN ACCORDANCE WITH SECTION 260500.

A. Fireproof fire stopping materials.

B. Provide U.L. category and file numbers of products.

1.05 QUALITY ASSURANCE: COMPLY WITH THE FOLLOWING.

A. ASTM E814 (UL 1479) - Test Method of Fire Tests of Through-Penetration Fire stops.

B. NEC 300-21 and NEC 800-52(b).

C. Conform to applicable code for fire resistance ratings and surface burning characteristics.

D. Provide certificate of compliance from authority having jurisdiction indicating approval of combustibility.

1.06 SEQUENCING

A. Sequence work to permit fire stopping materials to be installed after adjacent and surrounding work is complete.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

A. Flame-Safe FS500, FST600, FS900, FST900, or FSP1000.

B. Dow Corning 306548 Silicone RTV Foam.

C. 3M Fire Barrier Penetration Sealing Systems.

D. PENSIL 851, General Electric Company.

2.02 PERFORMANCE REQUIREMENTS

A. The requirements of this section shall be provided in addition to the requirements of Division 7.

B. Maintain required classification, fire, acoustic, and vapor barrier ratings for electrical installations penetrating walls, ceilings, and floors per ASTM E814 (UL 1479), NEC 300-21 and NEC 800-52(b).

1. Penetrations of classified area walls, ceiling and floors shall be sealed with the same material to maintain the integrity of area classification.
2. Penetrations of fire-rated walls, ceilings, and floors shall be sealed with a UL listed Through-Penetrations Fire-Stop System.
3. Penetrations of non-fire-rated walls, ceilings, and floors shall be filled and finished using the same finish material as the wall, ceiling, or floor.
4. Outlet box and lighting fixture installation in fire-rated walls, ceilings, and floors shall be in accordance with the UL Fire Resistance Directory.

C. Fire safety system shall not require de-rating the ampacity of electrical conductors.

D. Where mastic is used to seal the surface of the fire stop, the mastic shall be non-hardening.

E. Fire safety material shall not contract to allow transmission of smoke or water prior to exposure of a fire condition.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that openings are ready to receive the work of this section.

3.02 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter which may affect bond of fire stopping material.

B. Remove incompatible materials which affect bond.

3.03 APPLICATION

A. Apply primer and materials in accordance with manufacturer's instructions.

B. Apply fire stopping material in sufficient thickness to achieve rating to uniform density and texture.

C. Install material at walls or partition openings which contain penetrating sleeves, piping, ductwork, conduit, and other items requiring fire stopping.

D. Sleeves shall be of suitable length to accommodate fire stopping system used. Where conduit passes through a sleeve, the clearance around the conduit shall not be less than 1/2".

3.04 CLEANING

A. Clean adjacent surfaces of fire stopping materials.

3.05 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 262200
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. 10 CFR 431 - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.

B. IEEE 519 - IEEE Standard for Harmonic Control in Electric Power Systems; 2022.

C. IEEE C57.12.91 - IEEE Standard Test Code for Dry-Type Distribution and Power Transformers; 2026.

D. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000V or Less; 2023.

E. NEMA ST 20 - Dry Type Transformers for General Applications; 2021.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 750 kVA:
   1. Distribution transformers.
   2. Harmonics Mitigating (Canceling) Transformers.

1.04 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

D. Harmonics Canceling Transformers: NEMA ST-1, TP-1, TP-2 and IEEE 519-1992 compliance.

E. United States Department of Energy (DOE), United States Code (USC) and Code of Federal Regulations (CFR)
   1. 42 USC - Energy Conservation Program for Consumer Products Other Than Automobiles
   2. 10 CFR 431 – Energy Efficiency Program for Certain Commercial and Industrial Equipment, Subpart K – Distribution Transformers
   3. Appendix A to Subpart K of 10 CFR part 431 - Uniform Test Method for Measuring the Energy Consumption of Distribution Transformers

1.06 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.07 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 PRODUCTS

2.01 MANUFACTURERS (STANDARD DRY-TYPE)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ASEA Brown Boveri (ABB) /General Electric.
   2. Schneider Electric / Square D.
   3. Siemens.
   4. Eaton / Cutler-Hammer.

2.02 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.
   1. Low loss type with minimum efficiencies per NEMA TP1 and 10 CFR §431.196(a)(2) (DOE 2016 requirements) when operated at 35% of full load capacity. Efficiency shall be tested in accordance with NEMA TP2 and 10 CFR §431.193.

C. Coils: Continuous windings without splices except for taps.
   1. Internal Coil Connections: Brazed or pressure type.
   2. Coil Material: Copper.

2.03 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Taps for Transformers Smaller than 3 kVA: None.

E. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.

F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

G. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 80 deg C rise above 40 deg C ambient temperature.

H. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with NEMA TP 1, Class 1 efficiency levels.
   2. Tested according to NEMA TP 2.

I. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.
   1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
   2. Indicate value of K-factor on transformer nameplate.

J. Wall Brackets: Manufacturer's standard brackets.

K. Fungus Proofing: Permanent fungicidal treatment for coil and core.

L. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

M. Low-Sound-Level Requirements: Maximum sound levels, when factory tested, shall be in according to IEEE C57.12.91.

2.04 HARMONIC MITIGATING TRANSFORMERS

A. Zig-Zag Secondary with Phase Shift as noted.

B. Manufacturers:
   1. Basis of Design: Powersmiths International T-1000, or equal by:
   2. Power Quality International
   3. Mirus International

C. Insulation and Varnish systems: 220°C. Class, Epoxy polyester impregnation, 105°C. Temperature Rise in 40°C. Ambient.

D. All terminals. Including those for changing taps, must be readily accessible. Windings shall be continuous with terminations brazed or welded. 10KV BIL.

E. Compatible with all types of linear and non-linear current and future loads.

F. Impedance: Between 3.0% and 5.0% at rated KVA.

G. Zero sequence Impedance/reactance less than 0.95% and 0.3% respectively.

H. Zero sequence currents not coupled into primary windings.

I. Voltage Taps: Two 2.5% above and below nominal primary voltage.

J. Enclosure: NEMA 1 or 3 as required.

K. Efficiencies. Meet DOE 2016 Minimum Efficiency Requirements.

2.05 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.06 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 EXECUTION

3.01 EXAMINATION

A. Receive, inspect, handle, and store transformers according to NEMA PB 1.1.

B. Examine transformers before installation. Reject transformers that are damaged or rusted or have been subjected to water saturation. Reject transformers that have been left in precipitation of any kind or under leaks of any fluid, even if still in original packaging.

C. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

D. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

E. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

F. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written.

C. Install ALL floor mounted transformers as indicated on 6” housekeeping pads 3-inches larger than transformer, complying with manufacturer's written instructions, applicable requirements of NEC, NESC, NEMA, ANSI and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements. Provide NEC working clearances in front of transformers assuming they will require examination while energized.

D. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.

E. Transformers shall be on isolation pads. Install floor mounted units with bolts to equipment pad with neoprene/cork vibration mounts between transformer and pad. Comply with manufacturer's indicated installation method, if any.

F. Connect transformer units to electrical wiring system with flexible metal conduit or liquid tight flexible metal conduit. Comply with the requirements of other Division 16 sections.

G. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL STD 486A.

H. Back off shipping bolts on internal vibration isolators.

3.03 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

D. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
   1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
   2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
   3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

G. Provide equipment grounding connections for power/distribution transformers, sizes per NEC. Tighten connections to comply with tightening torques specified in UL STD 486A to assure permanent and effective grounding.

H. Transformer Testing
   1. Certified Test Reports in accordance with TP-1-2002 and TP-2.
   2. Open Circuit transformer tests, for calculating percent zero-sequence impedances and reactance as follows:
      a. With the transformer's primary terminals open-circuited, make a low impedance connection between secondary Terminals X1, X2 and X3.
      b. Connect a variable 60HZ power source between Secondary Terminals X1, X2, X3 and X0, which includes precision revenue class voltage and current measurement instrumentation.
      c. Increase 60HZ voltage across Terminals X1, X2, X3 and Terminal X0 until >2/3 full-scale readings are obtained on the voltage and current meters. In no case can the current reading exceed the full load rating of the winding under test. The values may be lower since impedance and reactance are linear.
      d. Calculate impedance in Ohms based on the measured voltage and current values.
      e. Based on the measured voltage, as a percentage of the rated voltage of the windings, calculate percent zero-sequence impedance and reactance.
   3. Closed Circuit Transformer Tests, for calculating transformer core and copper losses as follows:
      a. In accordance with e-Rated Transformer Corporation Standard Publications VAD1-2003 and VAD2- 2003.
      b. Measure Primary and Secondary voltage and current differences simultaneously, using ‘revenue class’ instrumentation and calculate excitation or no-load losses and impedances/load losses.
      c. Submit such reports as part of shop drawings submittals for each size typical transformers, based on tests done within a year or less time.
      d. Submit such reports for all the transformers for the project, prior to shipment.
   4. Design, manufacturing and testing of these transformers, in compliance with most current NEMA, IEEE and Industry standards and practices.
   5. Transformer Loss Calculations based on primary and secondary voltage and current differences measured simultaneously.

3.05 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.06 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 262413
SWITCHBOARDS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ANSI C12.1 - Electric Meters - Code for Electricity Metering; 2026.

B. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

C. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

E. NEMA PB 2 - Deadfront Distribution Switchboards; 2011.

F. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 1000 Volts or Less; 2023.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. NFPA 70E - Standard for Electrical Safety in the Workplace; 2027.

I. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

J. UL 891 - Switchboards; Current Edition, Including All Revisions.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. Section Includes:
   1. Service and distribution switchboards rated 600 V and less.
   2. Transient voltage suppression devices.
   3. Disconnecting and overcurrent protective devices.
   4. Instrumentation.
   5. Control power.
   6. Accessory components and features.
   7. Identification.

1.04 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.05 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail metering provisions.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Qualification Data: For qualified Installer.

D. Field Quality-Control Reports:
1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of over current protective device.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and connect factory-installed space heaters to temporary electrical service to prevent condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.08 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:
   1. Do not deliver or install switchboards until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet (201168 cm).

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than two weeks in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Owner's written permission.
   4. Comply with NFPA 70E.

1.09 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

1.11 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   5. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no less than one of each size and type.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ASEA Brown Boveri (ABB) /General Electric.
   2. Schneider Electric / Square D.

3. Siemens.
4. Eaton / Cutler-Hammer.

B. Front-Connected, Front-Accessible Switchboards:
1. Main Devices: Individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

C. Nominal System Voltage: 480Y/277 V.

D. Main-Bus Continuous: As indicated.

E. Indoor Enclosures: Steel, NEMA 250, Type 1.

F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

G. Barriers: Between adjacent switchboard sections.

H. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

I. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.

J. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

K. Removable, Hinged Rear Doors and Compartment Covers: Secured by captive thumb screws for access to rear interior of switchboard.

L. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

M. Buses and Connections: Three phase, four wire unless otherwise indicated.
1. Phase and Neutral Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated, or tin-plated, high-strength, electrical-grade aluminum alloy.
2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
3. Ground Bus: 1/4-by-2-inch hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
5. Neutral Buses: 50 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

N. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

O. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

P. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.02 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time delay, and I2t response.
   4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
   6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
   7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
   8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
      c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
      d. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
      e. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
      f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
      g. Under-voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
      h. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
      i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
   1. Fixed circuit-breaker mounting.
   2. Two-step, stored-energy closing.
   3. Full function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time time adjustments.
      c. Ground-fault pickup level, time delay, and I2t response.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Control Voltage: 125-V ac.

2.03 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
   1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
   2. Current Transformers: IEEE C57.13; 5 A, 60 Hz. Burden and accuracy shall be consistent with connected metering and relay devices.
   3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
   4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Switchboards shall have a 0.2% accurate digital meter connected (voltage and amp) to the primary bus after the main circuit breaker.

C. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
   1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
      a. Phase Currents, Each Phase: Plus or minus 0.2 percent.
      b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.2 percent.
      c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.2 percent.
      d. Megawatts: Plus or minus 2 percent.
      e. Megavars: Plus or minus 2 percent.
      f. Power Factor: Plus or minus 2 percent.
      g. Frequency: Plus or minus 0.5 percent.
      h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
      i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
      j. Contact devices to operate remote impulse-totalizing demand meter.
   2. Mounting: Display and control unit flush mounted in instrument compartment door.

D. Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1.
   1. Meters: 4-inch diameter or 6 inches (152.4 mm) square, flush, with anti-parallax 250-degree scales and external zero adjustment.
   2. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.

E. Instrument Switches: Rotary type with off position.
   1. Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.
   2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondary’s in a closed-circuit condition at all times.

F. Watt-Hour Meters and Wattmeters:
   1. Comply with ANSI C12.1.
   2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
   3. Suitable for connection to three- and four-wire circuits.
   4. Potential indicating lamps.
   5. Adjustments for light and full load, phase balance, and power factor.
   6. Four-dial clock register.
   7. Integral demand indicator.
   8. Contact devices to operate remote impulse-totalizing demand meter.
   9. Ratchets to prevent reverse rotation.
   10. Removable meter with draw-out test plug.
   11. Appropriate multiplier tag.

G. Impulse-Totalizing Demand Meter:
   1. Comply with ANSI C12.1.
   2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
   3. Cyclometer.
   4. Four-dial, totalizing kilowatt-hour register.
   5. Positive chart drive mechanism.
   6. Capillary pen holding a minimum of one month's ink supply.
   7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
   8. Capable of indicating and recording 15-minute integrated demand of totalized system.

2.04 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Control Circuits: 24-V dc.

C. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

D. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

E. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.05 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

2.06 IDENTIFICATION

A. Service Equipment Label: Labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 EXECUTION

3.01 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged. Reject switchboards that have been left in precipitation of any kind or under leaks of any fluid, even if still in original packaging.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Switchgear shall only be located in mechanical and electrical rooms. A spare set of fuses shall be provided with each project.

C. Equipment Mounting: Switchboards, transformers and motor control centers shall be set on concrete pads not less than 6” above finished floor. Comply with requirements for concrete base specified in Division 03.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to switchboards.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

E. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

F. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

G. Install filler plates in unused spaces of panel-mounted sections.

H. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

I. Comply with NECA 1.

3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:
   1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

D. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Switchboard will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection report, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.05 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

3.06 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION

SECTION 262713
ELECTRICITY METERING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes equipment for electricity metering by Owner.

1.03 DEFINITIONS

A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.

B. PC: Personal computer.

1.04 REFERENCE STANDARDS

A. ANSI C12.20 - American National Standard for Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes; 2022.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

C. NECA 400 - Standard for Installing and Maintaining Switchboards; 2007.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For electricity-metering equipment.
   1. Dimensioned plans and sections or elevation layouts.
   2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

C. Field quality-control reports.

D. Operation and Maintenance Data. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Application and operating software documentation.
   2. Software licenses.
   3. Software service agreement.
   4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center according to NECA 400.

1.08 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two weeks in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.09 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:
   1. Comply with requirements of utilities providing electrical power services.
   2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.10 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

PART 2 PRODUCTS

2.01 EQUIPMENT FOR ELECTRICITY METERING (NON-UTILITY)

A. Manufacturers: Subject to compliance with requirements, provide the following product:
   1. Shark 250-60-10-V4-D2-INP100S-20mAOS.

B. General Requirements for Owner's Meters:
   1. Comply with UL 1244.
   2. Meters used for billing shall have an accuracy of 1.0 percent of reading, complying with requirements in ANSI C12.20.
   3. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
   4. Identification: Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   5. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
   6. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
      a. Type: Split and solid core.
   7. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
   8. Building Automation System (BAS) Interface:
      a. One digital KY pulse to a user-definable increment of energy measurement. Match signal to BAS input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.
      b. Provide MODBUS over TCP/IP via Fast Ethernet port for integration with Division 23 BAS. Coordinate with BAS Vendor for connectivity and programming. Provide all required cabling for connection.

C. Kilowatt-hour Meter: Electronic three-phase meters, measuring electricity used.
   1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.

2. Display: LCD with characters not less than 0.25 inch (6.35 mm) high, indicating accumulative kilowatt-hours and current kilowatt load. Retain accumulated kilowatt-hour in a nonvolatile memory, until reset.
3. Display: Digital electromechanical counter, indicating accumulative kilowatt-hours.

D. Kilowatt-hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.
1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch (6.35 mm) high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand, and time and date of historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.

E. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway. Comply with Division 26 Section "Control-Voltage Electrical Power Cables."

F. Software: PC-based, a product of meter manufacturer, suitable for calculation of utility cost allocation and billing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install modular meter center according to NECA 400 switchboard installation requirements.

3.02 IDENTIFICATION

A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
2. Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for typewritten card with occupant's name.

3.03 FIELD QUALITY CONTROL

A. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
1. Connect a load of known kilowatt rating, 15 kW minimum, to a circuit supplied by metered feeder.
2. Turn off circuits supplied by metered feeder and secure them in off condition.
3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.

C. Electricity metering will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 262813
FUSES

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. Section Includes:
   1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor-control centers.
   2. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches, fuse-holders, and panelboards.
   3. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
   4. Spare-fuse cabinets.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
   1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   3. Current-limitation curves for fuses with current-limiting characteristics.
   4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
   5. Coordination charts and tables and related data.
   6. Fuse sizes for elevator feeders and elevator disconnect switches.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.
   3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
   4. Coordination charts and tables and related data.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248-11 for plug fuses.

1.06 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.07 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Littelfuse, Inc.

2.02 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.03 PLUG FUSES

A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

2.04 PLUG-FUSE ADAPTERS

A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuse-holders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

2.05 SPARE-FUSE CABINET

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

B. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

C. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FUSE APPLICATIONS

A. Cartridge Fuses. Unless otherwise indicated on Drawings:
   1. Service Entrance: Class L, fast acting.
   2. Feeders: Class L, fast acting
   3. Motor Branch Circuits: Class RK1 and Class RK5, time delay.
   4. Other Branch Circuits: Class J, fast acting.
   5. Control Circuits: Class CC, fast acting.

3.03 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install plug-fuse adapters in Edison-base fuse-holders and sockets. Ensure that adapters are irremovable once installed.

C. Install spare-fuse cabinet(s).

3.04 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

SECTION 262913
ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes the following enclosed controllers rated 600V and less:

B. Full-voltage manual.

C. Full-voltage magnetic.

D. Reduced-voltage magnetic.

E. Reduced-voltage solid state.

F. Multi-speed.

G. Related Section:

H. Division 26 Section "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200HP.

1.03 DEFINITIONS

A. Retain definition(s) remaining after this Section has been edited.

B. CPT: Control power transformer.

C. MCCB: Molded-case circuit breaker.

D. MCP: Motor circuit protector.

E. N.C.: Normally closed.

F. N.O.: Normally open.

G. OCPD: Overcurrent protective device.

H. SCR: Silicon-controlled rectifier.

1.04 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.

B. NEMA ICS 2 - Controllers, Contactors and Overload Relays Rated 600 Volts; 2000 (Reaffirmed 2020).

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. NFPA 70E - Standard for Electrical Safety in the Workplace; 2027.

E. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.05 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.

C. Show tabulations of the following:

D. Each installed unit's type and details.

E. Factory-installed devices.

F. Nameplate legends.

G. Short-circuit current rating of integrated unit.

H. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.

I. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.

J. Wiring Diagrams: For power, signal, and control wiring.

K. Qualification Data: For qualified testing agency.

L. Seismic Qualification Certificates: For enclosed controllers, accessories, and components, from manufacturer.

M. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

N. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

O. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.Retain first paragraph below if Contractor is responsible for field quality-control testing and inspecting.

P. Field quality-control reports.

Q. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

R. Routine maintenance requirements for enclosed controllers and installed components.

S. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.

T. Manufacturer's written instructions for setting field-adjustable overload relays.

U. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

V. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

W. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

B. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

E. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

1.08 PROJECT CONDITIONS

A. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

B. Notify Owner no fewer than 10 days in advance of proposed interruption of electrical systems.

C. Indicate method of providing temporary utilities.

D. Do not proceed with interruption of electrical systems without Owner's written permission.

E. Comply with NFPA 70E.

1.09 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than 3 of each size and type.

C. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than 2 of each size and type.

D. Indicating Lights: 2 of each type and color installed.

E. Auxiliary Contacts: Furnish 1 spare(s) for each size and type of magnetic controller installed.

F. Power Contacts: Furnish 3 spares for each size and type of magnetic contactor installed.

PART 2 PRODUCTS

2.01 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

D. Square D.

E. GE.

F. Eaton.

G. Configuration: Non-Reversing.
H. Surface mounting.
I. Red pilot light.
J. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
K. Manufacturers: Subject to compliance with requirements, provide products by one of the following
L. Square D.
M. GE.
N. Eaton.
O. Configuration: Non-reversing.
P. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button.
Q. Surface mounting.
R. Red pilot light.
S. Magnetic Controllers: Full voltage, across the line, electrically held.
T. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
U. Square D.
V. GE.
W. Eaton.
X. Configuration: Non-reversing.
Y. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
Z. Control Circuits: 120 V ac; obtained from integral CPT, with primary and secondary fuses and sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
AA. Solid-State Overload Relay:
BB. Switch or dial selectable for motor running overload protection.
CC. Sensors in each phase.
DD. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
EE. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
FF. Analog communication module.
GG. Retain first subparagraph below if alarm contacts on overload relays are required for local or remote alarm indication of a tripped overload relay.
HH. External overload reset push button.
II. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
JJ. Manufacturers: Subject to compliance with requirements, provide products by one of the following
KK. Square D.

LL. GE.

MM. Eaton.

NN. MCP Disconnecting Means:

OO. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

PP. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

QQ. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.

RR. N.C. alarm contact that operates only when MCP has tripped.

SS. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

TT. MCCB Disconnecting Means:

UU. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

VV. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

WW. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

XX. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.

YY. N.C. alarm contact that operates only when MCCB has tripped.

2.02 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.

B. Dry and Clean Indoor Locations: Type 1.

C. Outdoor Locations: Type 3R.

D. Kitchen and Wash-Down Areas: Type 4X, stainless steel.

E. Other Wet or Damp Indoor Locations: Type 4X-ss.

F. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: Type 12.

G. Hazardous Areas Indicated on Drawings: Type 9.

2.03 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

B. Push Buttons, Pilot Lights, and Selector Switches: Heavy duty, oil-tight type.

C. N.C., N.O. auxiliary contact(s).

D. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

E. Phase-Failure, Phase-Reversal, and Under-voltage and Over-voltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable under-voltage, over-voltage, and time-delay settings.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in Type 3R enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

I. Cover gaskets for Type 1 enclosures.

J. Terminals for connecting power factor correction capacitors to the load side of overload relays.

K. Spare control wiring terminal blocks, quantity as indicated; unwired.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section.

C. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

D. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

E. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

F. Install anchor bolts to elevations required for proper attachment to supported equipment.

G. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

H. Install fuses in each fusible-switch enclosed controller.

I. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

J. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

K. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

L. Install power factor correction capacitors. Connect to the line/load side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.

M. Comply with NECA 1.

3.03 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

C. Label each enclosure with engraved nameplate.

D. Label each enclosure-mounted control and pilot device.

3.04 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures. Use ‘Panduits’ where possible.

C. Connect selector switches and other automatic-control selection devices where applicable.

D. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

E. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

D. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.

E. Test continuity of each circuit.

F. Tests and Inspections:

G. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.

H. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.

I. Test continuity of each circuit.

J. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).

K. Test each motor for proper phase rotation.

L. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

M. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

N. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

O. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.

P. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after date of Substantial Completion.

Q. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

R. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

S. Enclosed controllers will be considered defective if they do not pass tests and inspections.

T. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

3.07 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION

SECTION 262923
VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.02 SECTION INCLUDES

A. Variable Frequency Drives

1.03 REFERENCE STANDARDS

A. AMCA 99 - Standards Handbook; 2025.

B. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.

C. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.

D. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

E. IEEE 519 - IEEE Standard for Harmonic Control in Electric Power Systems; 2022.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 RELATED SECTIONS

A. Section 23 05 13 - Motors

B. Section 23 05 48 - Vibration Isolation

C. Section 23 09 23 – Direct Digital Control Systems

D. Section 23 09 93 – Sequence of Operation

E. Section 23 34 16 - Centrifugal Fans

F. Section 23 34 13- Axial Fans

G. Section 23 73 00 – Air Handling Units (Up to 10,000 CFM)

H. Section 23 73 23 – Air Handling Units

I. Section 26 05 19 - Cable, Wire and Connectors, 600 Volt

J. Section 26 27 26 - Wiring Devices and Floor Boxes

1.05 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings

C. AMCA 99 - Standards Handbook

D. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes

E. AMCA 300 - Test Code for Sound Rating Air Moving Devices

F. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices

G. NEMA MG1 - Motors and Generators

H. NFPA 70 - National Electrical Code

I. IEEE - 112B, 587 and 519

1.06 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

C. Product Data:
   1. Provide literature that indicates dimensions, weights, capacities, ratings, performance, gages and finishes of materials, and electrical characteristics and connection requirements.
   2. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring.

D. Manufacturer's Installation Instructions.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00.

B. Maintenance Data: Include instructions for routine service, spare parts lists, and wiring diagrams.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, who issues complete catalog data on total product.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 26 05 00.

B. Accept products on site in factory fabricated protective containers, with factory installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.10 SCHEDULES ON DRAWINGS:

A. In general, all capacities of equipment and electrical characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of the owner. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Where installation instructions are not included in these Specifications or on the Drawings, the manufacturer's instructions shall be followed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ABB

B. Advanced Technology/Emerson

C. Eaton Dynamic

D. Siemens

E. Square D

F. Substitutions: Under provisions of Section 26 05 00. The equipment as supplied by any of the acceptable manufacturers or an approved equal shall comply with all of the provisions of this specification.

2.02 STANDARD 6 PULSE DRIVE

A. Furnish and install complete Pulse Width Modulation (PWM) or 6-step variable voltage, variable frequency speed controllers, as specified herein. All of the variable speed controllers shall be supplied by one manufacturer for this project. Motors must have a "bypass" switch as specified herein, to allow them to run if the controller malfunctions. All safety devices shall be energized. If an equal is proposed and accepted, Contractor must include installation and start-up by manufacturer's authorized personnel.

B. The Contractor shall furnish and install Variable Frequency Drive (VFD) motor controllers to vary the speed of the supply, return and relief air fans and pumps as shown in the fan and pump schedules on the Drawings. One controller shall control the speed of one motor only. See schedules and Drawings for quantity of controllers required.

C. The Variable Frequency Drive shall produce an adjustable AC voltage and frequency output for complete motor control using solid-state technology. The VFD shall be automatically controlled by a grounded electronic (4-20 ma) control signal. The drive shall produce an output volts/Hertz pattern to produce adequate starting torque under all conditions and operate smoothly at all operating speeds on variable torque load. The VFD shall be self-contained totally enclosed in NEMA 1 ventilated cabinet and capable of operation between 0 degrees and 40 degrees Celsius.

D. VFD's shall be ETL or UL listed. All components used on option units shall be ETL or UL listed. VFD's shall be designed to meet IEEE-587 and shall comply with all applicable provisions of the latest revision of the National Electric Code. The VFD shall comply with IEEE 519 with respect to the line noise generation.

E. The controllers shall be suitable for use with both standard and high efficiency 3-phase, squirrel cage, induction motors.

F. The service factor of the controller shall be equal to 0.95 with a power unit rating basis of 100 percent rated current continuous. Rated continuous current of the VFD shall be equal to 110% of driven motor’s FLA rating.

G. Each controller shall consist of a converter, D.C. link filter or supply power backfeed RF (radio frequency) filter, and an inverter section with each section modularized for ease of troubleshooting. PWM controllers shall also have output line filters for motor noise reduction. All components shall be factory mounted and wired on a dead-front, grounded, freestanding or wall mounted minimum NEMA 1 enclosure arranged for top or bottom conduit entry.

H. The controller enclosure shall be provided with the manufacturer's illustrated operating instructions and parts list mounted inside the enclosure door, manual speed control potentiometer, three position mode selector switch ("manual - off -auto", or equivalent), "power on" light, auxiliary relays and contacts for interlock and control wiring.

I. The 6-step VFD shall convert 460 volt, three-phase 60 Hertz utility power to variable voltage and frequency, three phase, AC power. Both 6-step and PWM shall be designed to provide step-less motor control from 20 percent to 100 percent of base speed.

2.03 FEATURES - THE VFD SHALL INCORPORATE THE FOLLOWING MINIMUM FEATURES:

A. Input power: 460 V/3 phase/60 Hz. Input fused disconnect switch

B. Provide a RS 485 Siemens FLN protocol interface port for all VFDs.

C. Provide a MODBUS TCP/IP interface and coordinate with Division 23 Building Automation System (BAS) Vendor for connection and programming requirements. Provide all required cabling and connections.

D. Input line filter capable of protecting the electronics against transient voltage spikes or notches, as well as back feed of RF (Radio Frequency) interference, into the incoming power supply.

E. Fuse less electronic power protection for ground fault protection. Isolation transformers for ground fault protection are not acceptable. Ground fault shall not cause fuses to open.

F. The following door mounted devices:
   1. "Power on" light
   2. Hand/off/auto (or equivalent) selector switch
   3. Manual speed potentiometer (1000 ohms) and ammeter
   4. Digital display unit
   5. Status, frequency/percent speed and fault diagnostics

G. Minimum/maximum adjustable speeds

H. Disconnect switch and thermal motor overloads

I. Manual speed control during manual control mode

J. A thermally protected transfer switch for manual bypass of the VFD

K. The VFD shall have auto-restart after power failure, power surge, undercurrent and over current. Over current restart shall be limited to a maximum of five attempts.

L. Electronic and control follower board

M. External signal shutdown feature (i.e. fire/smoke, freeze, operable and normal bypass mode)

N. Output terminal for remote frequency and current meters (4 to 20 ma)

O. Trip relay for remote fault indication

P. A door interlock, designed to cut power to the unit when the door is opened

Q. Instantaneous over current trip

R. Unit over temperature protection

S. Motor phase loss protection

T. Input phase loss protection

U. Line side reactor

V. A bypass switch which shall simultaneously isolate the VFD from input and output power, and provide line power directly to the motor. The bypass switch shall also have the capability of starting and stopping the motor. The switch shall consist of an enclosure separate from the VFD. The following shall be mounted on the enclosure door:
   1. Door interlocked main input disconnect switch
   2. Power on light
   3. "Drive-off-bypass" manual mode selector switch
   4. A "normal operation-off-test" selector to facilitate static testing of the drive at startup or while the motor is operating in the bypass mode
   5. Speed lockout circuitry to allow the lockout or bypass of at least three speed ranges within the full range of the controller

2.04 DISCONNECT AND INTERFACE - THE FOLLOWING SHALL BE MOUNTED WITHIN THE ENCLOSURE:

A. Line, load and bypass contactors capable of interrupting the locked rotor rating of the driven motor. Bypass and load contactors must be mechanically interlocked to prevent simultaneous closure.

B. Overload relay

C. A dedicated terminal strip to allow the controller to be interconnected with external shutdown contacts from smoke detectors, fire detectors, damper interlocks, freeze-stats, time clocks, remote master on-off switch, energy management and control system (FCMS) and input signals. The system must be capable of shutdown whether in the drive or in the bypass mode by remote detectors.

2.05 FAULT DETECTION DEVICES - A DIAGNOSTIC FAULT DETECTION CENTER SHALL BE INTEGRAL TO EACH VFD, PROVIDING AN INDICATION OF THE FOLLOWING FAULT CONDITIONS:

A. External fault
B. Processor line fault
C. Low AC line voltage
D. High AC line voltage
E. Current overload
F. High DC buss voltage
G. VFD output fault

2.06 CONTROL

A. All control adjustments shall be made without the necessity of an extender board of specialized meters, but rather from front access adjustable potentiometers.
B. Low voltage logic and 115 V control circuits shall be electrically isolated from the power circuits. Signal circuit common shall be grounded.
C. The VFD shall include a power ride-through feature to allow continuous operation through up to a three to five cycle line loss.
D. Electronic output overload protection shall be provided to eliminate the use of bimetallic overloads. The drive shall not be phase sequence sensitive.
E. The VFD shall have independently adjustable acceleration and deceleration circuits of 5 to 120 seconds. Extended time periods are also acceptable.
F. The VFD shall have full function output current limit adjustable from 10 to 100 percent.

2.07 SYSTEM OPERATION

A. Selector switch in the "off" position - the controller run circuit shall be open and the system shall not operate.
B. Selector switch in the "manual" position - the speeds of the motors shall be controlled by the manual speed potentiometer.
C. Selector switch in the "auto" position - operation shall be via the input 0 to 10 VDC signal with the output speed proportional to the input signal. If required for incorporation into the controls scenario, the VFD manufacturer shall furnish a pressure transducer mounted in the drive enclosure to convert a 3 to 15 psi (103.42 kPa) pressure signal to a 0 to 10 VDC signal.
D. The bypass switch shall provide the ability to service the control in bypass operation while not de-energizing the motor. It shall also allow for start/stop functions for the motor.
E. In case of an output ground fault or similar abnormal output condition, any VFD serving multiple units shall be able to automatically alternate its output to either the duty device or the standby device. The VFD shall be fully operational after an output ground fault condition.

PART 3 EXECUTION

3.01 AS PART OF THE PURCHASE PRICE AND AGREEMENT, A FULL, UNCONDITIONAL, ONE (1) YEAR WARRANTY ON ALL PARTS AND LABOR SHALL BE PROVIDED. THE WARRANTY SHALL INCLUDE ALL PARTS, LABOR, SHIPPING, FIELD SERVICE OR TECHNICIAN TIME, LABOR OR TRAVEL EXPENSES AND VERBAL OR WRITTEN CORRESPONDENCE WITH THE VFD MANUFACTURER OR HIS REPRESENTATIVES, INCLUDING THAT WHICH MIGHT BE INCIDENTAL TO THE PROPER INSTALLATION AND OPERATION OF THE EQUIPMENT.

3.02 THE MANUFACTURER'S REPRESENTATIVE SHALL PROVIDE A LIST OF RECOMMENDED SPARE PARTS.

3.03 THE MANUFACTURER'S REPRESENTATIVE SHALL PROVIDE TERMINAL BLOCK TO TERMINAL BLOCK WIRING DIAGRAMS COORDINATED WITH THE OWNER TO PROVIDE A COMPLETE AND FUNCTIONAL OPERATING SYSTEM. FURNISH DETAILED DRAWINGS SHOWING CONSTRUCTION, DIMENSIONS, WIRING DIAGRAMS AND INSTALLATION PROCEDURES FOR ENGINEER'S APPROVAL.

3.04 THE MANUFACTURER SHALL PROVIDE A FACTORY TRAINED TECHNICIAN TO START THE VFD AND PLACE IT INTO OPERATION.

3.05 THE SUCCESSFUL VENDOR SHALL PROVIDE FOR AND PRESENT TO THE OWNER, AT NO COST TO THE OWNER, A TRAINING AND TROUBLESHOOTING COURSE AT THE OWNER'S LOCATION. THIS COURSE SHALL BE COMPRISED OF A MINIMUM OF TWO (2) DAYS OF CLASSROOM INSTRUCTION FOR A MINIMUM OF FOUR (4) HOURS PER DAY COMPLETE WITH VISUAL AIDS, DOCUMENTATION, CIRCUIT DIAGRAMS AND HANDS-ON TRAINING FOR A GROUP OF APPROXIMATELY 6 PEOPLE. THIS COURSE IS NOT TO BE CONSTRUED AS A SALE MEETING, BUT RATHER AS A SCHOOL TO FAMILIARIZE THE OWNER WITH THE CARE, TROUBLESHOOTING AND SERVICING OF THE VFD.

3.06 VFD'S SHALL BE WALL HUNG UNITS. CONTRACTOR SHALL PROVIDE UNISTRUT MOUNTING BRACKET FOR DRIVES. CONTRACTOR SHALL REINFORCE THE WALL STUDS WITH BRACING AS REQUIRED TO ADEQUATELY SUPPORT THE DRIVE. INSTALLATION OF THE VFD SHALL ALLOW FOR CLEARANCE IN FRONT OF THE DRIVE AS REQUIRED BY THE LATEST REVISION OF THE NATIONAL ELECTRIC CODE FOR AN ELECTRICAL PANEL.

3.07 APPLICATION – PROVIDE VFD'S IN THE FOLLOWING EQUIPMENT:

A. All HVAC Air Handling Units, Outside Air Units, Fans, and Pumps shall have a VFD.

3.08 TESTING - VFD'S SHALL BE SHIPPED TO THE AIR HANDLING UNIT, PUMP OR FAN MANUFACTURER FOR TESTING. THE UNITS SHALL BE OPERATED OVER THE FULL SPEED RANGE TO CERTIFY VIBRATION LIMITS ARE MET.

END OF SECTION

SECTION 263213
ENGINE GENERATORS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
   1. Gas engine.
   2. Unit-mounted cooling system.
   3. Unit-mounted and Remote-mounting control and monitoring.
   4. Performance requirements for sensitive loads.
   5. Load banks.
   6. Outdoor enclosure.

B. Related Sections include the following:
   1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.03 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. LP: Liquid petroleum.

1.04 REFERENCE STANDARDS

A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

B. IEEE 115 - IEEE Guide for Test Procedures for Synchronous Machines Including Acceptance and Performance Testing and Parameter Determination for Dynamic Analysis; 2019.

C. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2024, with Amendment.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. NFPA 99 - Health Care Facilities Code; 2027.

F. NFPA 110 - Standard for Emergency and Standby Power Systems; 2025.

G. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

H. UL 891 - Switchboards; Current Edition, Including All Revisions.

I. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.

J. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.05 SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
   1. Thermal damage curve for generator.

2. Time-current characteristic curves for generator protective device.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
   2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
   4. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
      b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: For manufacturer.

E. Source quality-control test reports.
   1. Certified summary of prototype-unit test report.
   2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
   3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
   4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
   5. Report of sound generation.
   6. Report of exhaust emissions showing compliance with applicable regulations.
   7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

H. Warranty: Special warranty specified in this Section.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles (321.87 kilometers) of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with ASME B15.1.

G. Comply with NFPA 37.

H. Comply with NFPA 70.

I. Comply with NFPA 99.

J. Comply with NFPA 110 requirements for Level 1

K. Emergency power supply system.

L. Comply with UL 2200.

M. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

N. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.07 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
1. Ambient Temperature: 5 to 40 deg C.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 1000 feet (30480 cm).

1.08 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in Division 07 Section "Roof Accessories."

1.09 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 5 years from date of Substantial Completion.

1.10 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
   2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
   3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Caterpillar.
   2. Kohler.
   3. Onan / Cummins Power Generation.
   4. Owner and Engineer approved equal.

2.02 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
   1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:
   1. Power Output Ratings: Nominal ratings as indicated.
   2. Output Connections: Three-phase, four wire.
   3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Accessory Panel: Provide an accessory panel within the generator enclosure to serve all chargers, controllers, heaters, and any other required accessory within the generator set enclosure.

1. Include three phase step down transformer to accept 480 VAC, 3-phase Delta input from building.

E. Emergency Power Off Button:
   1. Red “Mushroom” button to be field located as required.
   2. Provide underground wiring to generator set as required for a fully working system.

F. Generator-Set Performance:
   1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
   2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
   3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
   4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
   5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
   6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
   7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
   8. Start Time: Comply with NFPA 110, Type 10, system requirements.

G. Generator-Set Performance for Sensitive Loads:
   1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
      a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
   2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
   3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
   4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
   5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
   6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
   7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
   8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not

less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
    a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.03 ENGINE

A. Fuel: Natural gas.

B. Lubrication System: The following items are mounted on engine or skid:
    1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
    2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
    3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

C. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

D. Governor: Adjustable isochronous, with speed sensing.

E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
    1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
    2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
    3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
    4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
    5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
        a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
        b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Cooling System: Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump.
    1. Configuration: Vertical air discharge.
    2. Radiator Core Tubes: Aluminum.
    3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
    4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
    5. Fan: Driven by totally enclosed electric motor with sealed bearings.
    6. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
    7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

G. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Minimum sound attenuation of 25 dB at 500 Hz.
   2. Sound level measured at a distance of 10 feet (304.8 cm) from exhaust discharge after installation is complete shall be 85 dBA or less.

H. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

I. Starting System: 24-V electric, with negative ground.
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. Cranking Cycle: As required by NFPA 110 for system level specified.
   4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
   6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
   7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
   8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
      a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
      b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
      c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
      d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
      e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
      f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.04 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel.

E. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel features shall include the following:
   1. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
   2. Switchboard Construction: Freestanding unit complying with Division 26 Section "Switchboards."
   3. Switchgear Construction: Freestanding unit complying with Division 26 Section "Low-Voltage Switchgear."
   4. Current and Potential Transformers: Instrument accuracy class.

F. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
   1. AC voltmeter.
   2. AC ammeter.
   3. AC frequency meter.
   4. DC voltmeter (alternator battery charging).
   5. Engine-coolant temperature gage.
   6. Engine lubricating-oil pressure gage.
   7. Running-time meter.
   8. Ammeter-voltmeter, phase-selector switch(es).
   9. Generator-voltage adjusting rheostat.
   10. Fuel tank derangement alarm.
   11. Fuel tank high-level shutdown of fuel supply alarm.
   12. Generator overload.

G. Indicating and Protective Devices and Controls:
   1. AC voltmeter.
   2. AC ammeter.
   3. AC frequency meter.
   4. DC voltmeter (alternator battery charging).
   5. Engine-coolant temperature gage.
   6. Engine lubricating-oil pressure gage.
   7. Running-time meter.
   8. Ammeter-voltmeter, phase-selector switch(es).
   9. Generator-voltage adjusting rheostat.
   10. Start-stop switch.
   11. Overspeed shutdown device.
   12. Coolant high-temperature shutdown device.
   13. Coolant low-level shutdown device.

14. Oil low-pressure shutdown device.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Generator overload.

H. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

I. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."

J. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

K. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
1. Engine high-temperature shutdown.
2. Lube-oil, low-pressure shutdown.
3. Overspeed shutdown.
4. Remote emergency-stop shutdown.
5. Engine high-temperature prealarm.
6. Lube-oil, low-pressure prealarm.
7. Fuel tank, low-fuel level.
8. Low coolant level.

L. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

M. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.05 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator rating.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.

3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

C. Generator Circuit Breaker: Insulated-case, electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

D. Generator Disconnect Switch: Molded-case type, 100 percent rated.
1. Rating: Matched to generator output rating.
2. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.

E. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

F. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.06 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H (180°C).

D. Temperature Rise at Capacity indicated: 105°C.

E. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.

2.07 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Description: Prefabricated or pre-engineered walk-in enclosure with the following features:
   1. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
   2. Revise wind speed in first subparagraph below to suit local conditions.
   3. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
   4. Space Heater: Thermostatically controlled and sized to prevent condensation.
   5. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
   6. Hinged Doors: With padlocking provisions.
   7. Revise first subparagraph below if forced ventilation rather than convection ventilation is required.
   8. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
   9. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
   10. Muffler Location: Within enclosure.

C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
   1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
   2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

D. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
   1. AC lighting system and connection point for operation when remote source is available.
   2. DC lighting system for operation when remote source and generator are both unavailable.

E. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.08 MOTORS

A. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.09 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of

sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Standard neoprene.

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
   1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
   1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
   2. Full load run.
   3. Maximum power.
   4. Voltage regulation.
   5. Transient and steady-state governing.
   6. Single-step load pickup.
   7. Safety shutdown.
   8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
   9. Report factory test results within 10 days of completion of test.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Generators and engines that have been under any kind of precipitation or fluid leaks will be rejected.

C. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Concrete Bases: Unless otherwise indicated on Drawings: 12 inches (304.8 mm) high, reinforced, with chamfered edges. Extend base 6 inches (152.4 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

D. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch (25.4 mm). Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."
   1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

F. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

G. The location of the emergency power generator shall be away from fresh air intakes and other areas where fumes may enter the building.

3.03 CONNECTIONS

A. Piping installation requirements are specified in Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect engine exhaust pipe to engine with flexible connector.

D. Connect fuel piping to engines with a gate valve and union and flexible connector.
   1. Natural-gas piping, valves, and specialties for gas distribution are specified in Division 22 Section "Facility Natural-Gas Piping."

E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

G. The following equipment shall be connected to the generator: fire alarm system, PA system, security system, kitchen freezers and coolers, gym light fixtures, energy management system, server room, A/C for server room, select administrative office receptacles, elevators, auditorium egress lighting, emergency lights, and select light fixtures. One 110v double duplex receptacle and one overhead light in each mechanical room, electrical room, and data closet shall be connected to the generator

3.04 IDENTIFICATION

A. Identify system components according to Division 22 Section "Identification for Plumbing Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:
   1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
   3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
      a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
      b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
      c. Verify acceptance of charge for each element of the battery after discharge.
      d. Verify that measurements are within manufacturer's specifications.
   4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
   5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
   6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
   7. Exhaust Emissions Test: Comply with applicable government test criteria.
   8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
   9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
   10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

E. Coordinate tests with tests for transfer switches and run them concurrently.

F. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

G. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

I. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

J. Remove and replace malfunctioning units and retest as specified above.

K. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

L. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

M. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 263600
TRANSFER SWITCHES

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.

B. NEMA ICS 1 - Industrial Control and Systems: General Requirements; 2022.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. NFPA 99 - Health Care Facilities Code; 2027.

E. NFPA 110 - Standard for Emergency and Standby Power Systems; 2025.

F. UL 508 - Industrial Control Equipment; Current Edition, Including All Revisions.

G. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:
   1. Automatic transfer switches.
   2. Bypass/isolation switches.
   3. Remote annunciation systems.

B. Related Sections include the following:
   1. Division 21 Section "Electric-Drive, Centrifugal Fire Pumps" for automatic transfer switches for fire pumps.
   2. Division 21 Section "Electric-Drive, Vertical-Turbine Fire Pumps" for automatic transfer switches for fire pumps.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
   1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
   2. Retain paragraph and subparagraphs below if required by seismic criteria applicable to Project. Coordinate with Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
   3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Qualification Data: For manufacturer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NEMA ICS 1.

F. Comply with NFPA 70.

G. Comply with NFPA 99.

H. Comply with NFPA 110.

I. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
   1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Owner's written permission.

1.07 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Transfer Switches Using Molded-Case Switches or Circuit Breakers:
      a. General Electric (GE) / Zenith.
      b. Kohler.
      c. Onan / Cummins.
      d. ASCO.

2.02 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
   1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
   1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
   2. Switch Action: Double throw; mechanically held in both directions.
   3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Switching. Where four-pole switches are indicated, provide overlapping neutral contacts.

H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

I. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

J. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

K. Battery Charger: For generator starting batteries.
   1. Float type rated 10 A.
   2. Ammeter to display charging current.
   3. Fused ac inputs and dc outputs.

L. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

M. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."
   1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

N. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.03 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

G. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.

H. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

I. Automatic Transfer-Switch Features:
   1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
   2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
   3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
   4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
   5. Test Switch: Simulate normal-source failure.
   6. Switch-Position Pilot Lights: Indicate source to which load is connected.
   7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

2.04 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:
    1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    2. Switch position.
    3. Switch in test mode.
    4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
    1. Indicating Lights: Grouped for each transfer switch monitored.
    2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
    3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
    4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.05 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 EXECUTION

3.01 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Floor-Mounting Switch: Anchor to floor by bolting.
   1. Concrete Bases: Unless otherwise indicated on Drawings: 8 inches (203.2 mm) high, reinforced, with chamfered edges. Extend base 6 inches (152.4 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

C. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

D. Identify components according to Division 26 Section "Identification for Electrical Systems."

E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.02 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables.'

3.03 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
   2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
   3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
      a. Check for electrical continuity of circuits and for short circuits.
      b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
      c. Verify that manual transfer warnings are properly placed.
      d. Perform manual transfer operation.
   5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
      a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
      b. Simulate loss of phase-to-ground voltage for each phase of normal source.
      c. Verify time-delay settings.
      d. Verify pickup and dropout voltages by data readout or inspection of control settings.

e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
   a. Verify grounding connections and locations and ratings of sensors.

D. Testing Agency's Tests and Inspections:
1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.
4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
   e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
   f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
   g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
   a. Verify grounding connections and locations and ratings of sensors.

E. Coordinate tests with tests of generator and run them concurrently.

F. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

G. Remove and replace malfunctioning units and retest as specified above.

H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION

SECTION 264113
LIGHTNING PROTECTION FOR STRUCTURES

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. NFPA 780 - Standard for the Installation of Lightning Protection Systems; 2026.

B. UL 96 - Lightning Protection Components; Current Edition, Including All Revisions.

C. UL 96A - Standard for Installation Requirements for Lightning Protection Systems; Current Edition, Including All Revisions.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 SUMMARY

A. Section includes lightning protection for structures.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Commissioning Functional Tests:
   1. In the event project specific functional test reports/checklists are not provided by the Owner or Commissioning Consultant, the Subcontractor shall develop and submit project specific functional test report/checklist for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested.
   2. CONTENT
      a. The functional test report/checklists shall include operating the system and components through each of the written sequences of operation, for all modes of operation for each identified sequence, including but not limited to: startup, shutdown, unoccupied mode, manual mode, staging, miscellaneous alarms, power failure, CO2 purge, CO purge, economizer, security alarm when impacted, and interlocks with other systems or equipment, as applicable.
   3. FORMAT
      a. The test report/checklist shall be formatted in an action-response format with a Yes/No checkbox to allow for clearly marking whether or not the identified anticipated response for each applicable control device and monitored point was achieved.
      b. The format of each report/checklist shall be tabular including step-by-step procedures so that the test is clear, sequential, and repeatable with a single line entry for each specific action and a single line entry for each applicable response (both hardware/device related as well as soft responses, e.g. alarms, trends, set-point changes, etc.).
   4. The requirements stipulated in this section are in accordance with Section 01 91 00 – General Commissioning Requirements, and provide requirements for the Contractor.

C. Shop Drawings: For air terminals and mounting accessories.
   1. Layout of the lightning protection system, along with details of the components to be used in the installation.
   2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

D. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

E. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

F. Field quality-control reports.

G. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.

H. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
   1. Ground rods.
   2. Ground loop conductor.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL as a Master Installer/Designer, trained and approved for installation of units required for this Project.

B. System Certificate:
   1. UL Master Label.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.06 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 PRODUCTS

2.01 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, Class I copper.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. East Coast Lightning Equipment Inc.
      b. ERICO International Corporation.
      c. Harger.
      d. Heary Bros. Lightning Protection Co. Inc.
      e. Independent Protection Co.
      f. Preferred Lightning Protection.
      g. Robbins Lightning, Inc.
      h. Thompson Lightning Protection, Inc.
   2. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less than half the height of the terminal.
   3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in Division 07 roofing Sections.

C. Main and Bonding Conductors: Copper.

D. Ground Loop Conductor: The same size and type as the main conductor except tinned.

E. Ground Rods: Copper-clad steel; 3/4 inch (19.05 mm) in diameter by 10 feet (304.8 cm) long.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

C. Conceal the following conductors:
   1. System conductors.
   2. Down conductors.
   3. Interior conductors.
   4. Conductors within normal view of exterior locations at grade within 200 feet (6096 cm) of building.

D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

E. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.

F. Bond extremities of vertical metal bodies exceeding 60 feet (1828.8 cm) in length to lightning protection components.

G. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure.
   1. Bury ground ring not less than 24 inches (609.6 mm) from building foundation.
   2. Bond ground terminals to the ground loop.
   3. Bond grounded building systems to the ground loop conductor within 12 feet (365.76 cm) of grade level.

H. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.02 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.03 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

END OF SECTION

SECTION 265100
INTERIOR LIGHTING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Interior lighting fixtures, lamps, and ballasts.
   2. Emergency lighting units.
   3. Exit signs lighted
   4. Lighting fixture supports.
   5. Retrofit kits for fluorescent lighting fixtures.

B. Related Sections include the following:
   1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multiple lighting relays and contactors.
   2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
   3. Division 26 Section "Theatrical Lighting" for theatrical lighting fixtures and their controls.

1.03 DEFINITIONS

A. BF: Ballast factor.

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. RCR: Room cavity ratio.

1.04 REFERENCE STANDARDS

A. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.

B. ASTM A580/A580M - Standard Specification for Stainless Steel Wire; 2023.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

1.05 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Emergency lighting units including battery and charger.
   3. Ballast.
   4. Energy-efficiency data.
   5. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Submittals" Article in Division 23 Section "Diffusers, Registers, and Grilles."

6. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."
7. Life, output, and energy-efficiency data for lamps.
8. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
    a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
    b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
1. Wiring Diagrams: Power and control wiring.

C. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:
1. Lamps: Specified units installed.
2. Accessories: Cords and plugs.

D. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

E. Qualification Data: For agencies providing photometric data for lighting fixtures.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

H. Warranties: Special warranties specified in this Section.

1.06 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

E. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

F. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.
1. Obtain Architect's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.08 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Emergency Lighting Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
   2. Warranty Period for Emergency Fluorescent Ballast Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.
   2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.

C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
   1. Warranty Period: Two year(s) from date of Substantial Completion.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Battery and Charger Data: One for each emergency lighting unit.
   4. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
   5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
   6. At a minimum, the electrical contractor shall provide two (2) cases of fluorescent lamps and one (1) case of electronic ballasts with other attic stock items upon project completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Approved Manufacturers: The following manufacturers and their subsidiaries are approved:
   1. Phillips / Signify
   2. Eaton
   3. Acuity
   4. Hubbell
   5. Leviton

B. Substitutions:
   1. Procedure as indicated in 26 05 00-1.3(B)

C. Contractor shall furnish full photometric calculation study for all affected areas for fixtures other than basis-of-design as indicated on Drawings.

2.02 GENERAL REQUIREMENTS:

A. Refer to Drawings for basis-of-design Light Fixture Schedule for all characteristics.

2.03 EXIT SIGNS LIGHTED

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
   1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
   2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
      a. Battery: Sealed, maintenance-free, nickel-cadmium type.
      b. Charger: Fully automatic, solid-state type with sealed transfer relay.
      c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
      d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
      f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
      g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.
   3. Master/Remote Sign Configurations:
      a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
      b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.04 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A580/A580M, Composition 302 or 304, annealed stainless steel, 12 gage.

E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 EXECUTION

3.01 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
   1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (152.4 mm) from lighting fixture corners.
   2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
   3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
   4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches (1219.2 mm), brace to limit swinging.
   2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Adjust aim-able lighting fixtures to provide required light intensities.

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

F. All emergency lights shall have a disconnect switch, so they can be serviced. Or, the emergency lighting shall be clearly labeled, so it is clear which breaker should be cut before servicing.

3.02 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION

SECTION 265500
BUILDING LIGHTING AND RECEPTACLE CONTROLS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

1.02 SUMMARY

A. Section Includes:
   1. Digital Occupancy and Daylighting Sensor Control
      a. Emergency Lighting Control

B. Related Section
   a. Edit the following paragraphs to coordinate with other sections in the Project Manual.
   b. Section 260926 – Lighting Control Panel Boards: Lighting panels (switching) controlled by Digital Network Lighting Control System.
   c. Section 260936 – Modular Dimming Controls: Digital Lighting Management
   d. Section 262726 - Wiring Devices: Receptacles
   e. Section 265113 – Interior Lighting Fixtures, Lamps, and Ballasts: Fluorescent electronic dimming ballasts.
   f. Section 25000 – Integrated Automation Building integrator shall provide integration of the lighting control system with Building Automation Systems.
   g. Drawings and general provision of the Contact, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section
   h. Electrical Sections, including wiring devices, apply to the work of this Section.

C. Control Intent – Control Intent includes, but is not limited to:
   a. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
   b. Initial sensor and switching zones
   c. Initial time switch settings
   d. Task lighting and receptacle controls
   e. Emergency Lighting control

1.03 REFERENCES

A. Edit the following to include only those standards referenced elsewhere in this Section.

B. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) (www.ansi.organd www.ieee.org)

C. Underwriter Laboratories of Canada (ULC) (www.ulc.ca)

D. International Electrotechnical Commission (www.iec.ch)

E. International Organization for Standardization (ISO) (www.iso.ch):

F. National Electrical Manufacturers Association (NEMA) (www.nema.org)

G. WD1 (R2005) - General Color Requirements for Wiring Devices.

H. Underwriters Laboratories, Inc. (UL) (www.ul.com):
   a. 916 – Energy Management Equipment.
   b. 924 – Emergency Lighting

1.04 SYSTEM DESCRIPTION & OPERATION

A. The Lighting Control and Automation system as defined under this section covers the following equipment:

a. Digital Room Controllers – Self-configuring, digitally addressable one, two or three relays controllers with integral current thyristor, 0-10 volt control for ballasts (if applicable) and single relay application-specific plug load controllers.
b. Digital Occupancy Sensors – Self-configuring, digitally addressable and calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
c. Digital Switches – Self-configuring, digitally addressable pushbutton switches, dimmers, and scene switches with two-way active infrared (IR) communications.
d. Digital Photosensors – Single-zone closed loop and multi-zone open loop daylighting sensors with two-way active infrared (IR) communications can provide switching or dimming control for daylight harvesting.
e. Configuration Tools – Handheld remote for room configuration provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet (914.4 cm) away. Unit to have Organic LED display, simple pushbutton interface, and allow send and receive of room variables and store of occupancy sensor settings. Computer software also customizes room settings.
f. Handheld remotes for personal control – One-button dimming, two-button on/off, or five-button scene remotes provide control using infrared communications. Remote may be configured in the field to control selected loads or scenes without special tools.
g. Digital Lighting Management (DLM) local network – Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
h. Network Bridge – provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS).
i. Segment Manager – provides web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
j. Emergency Lighting Control Unit (ELCU) – allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

1.05 SUBMITTALS

A. Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.

B. Shop Drawings:
   a. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed (standard diagrams will not be accepted).
   b. Scale drawing for each area showing exact location of each sensor, room controller, network bridges, digital plug load room controller, segment managers, and digital switch.

C. Product Data: Catalog sheets, specifications and installation instructions.

D. Include data for each device which:
   a. Indicates where sensor is proposed to be installed.
   b. Prove that the sensor is suitable for the proposed application.

1.06 QUALITY ASSURANCE

A. Manufacturer: Minimum 10 years experience in manufacture of lighting controls.

1.07 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
   a. Ambient temperature: 0° to 40° C (32° to 104° F).

b. Relative humidity: Maximum 90 percent, non-condensing.

1.08 WARRANTY

A. Provide a five year complete manufacturer's warranty on all products to be free of manufacturers' defects.

1.09 MAINTENANCE

A. Spare Parts:
   a. Provide 5 spares of each product listed below to be used for maintenance. Electrical contractor shall deliver items to maintenance within 30 days of substantial completion.
   2. Room Controllers
   3. Occupancy Sensors
   4. Emergency Bypass controllers
   5. Low voltage switches
   6. Daylighting harvesting photocells

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturer:
   a. WattStopper
   b. Eaton – Greengate
   c. Crestron

2.02 SINGLE / DUAL RELAY WALL SWITCH OCCUPANCY SENSORS

A. Type PW: Manual-ON, Automatic-OFF passive infrared (PIR) wall switch occupancy sensor Furnish the Company's model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper PW-100, PW-200, PW-103, PW-203, PW-301, PW-302, WS-301..

B. Type UW: Manual-ON, Automatic-OFF ultrasonic wall switch occupancy sensor with Furnish the Company's model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper UW-100, UW-200.

C. Type DW: Manual-ON, Automatic-OFF dual technology (passive infrared and ultrasonic) wall switch occupancy sensor Furnish the Company's model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper DW-100, DW-200, DW-103, DW-203, DSW-100, DSW-200, DW-103, DW-203, DSW-301, DSW-302.

2.03 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

A. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors and accessories which suit the lighting and electrical system parameters. Passive infrared only sensors shall not be used for classroom applications.

B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
   a. Digital calibration and pushbutton programming for the following variables:
   2. Sensitivity – 0-100% in 10% increments
   3. Time delay – 1-30 minutes in 1 minute increments
   4. Test mode – Five second time delay

5. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
6. Walk-through mode
7. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
    a. One or two RJ-45 port(s) for connection to DLM local network.
    b. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
    c. Device Status LEDs including:
8. PIR Detection
9. Ultrasonic detection
10. Configuration mode
11. Load binding
    a. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
    b. Manual override of controlled loads.

C. Units shall not have any dip switches or potentiometers for field settings.

D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

E. All devices shall be hard wired. No wireless devices shall be permitted.

F. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

2.04 DIGITAL WALL SWITCHES

A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration; available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening. Wall switches shall include the following features:
    a. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
    b. Removable buttons for field replacement with engraved buttors and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
    c. Red configuration LED on each switch that blinks to indicate data transmission.
    d. Blue Load/Scene Status LED on each switch button with the following characteristics:
    2. Bi-level LED
    3. Dim locator level indicates power to switch
    4. Bright status level indicates that load or scene is active
        a. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.

B. Two RJ-45 ports for connection to DLM local network.

C. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching.

D. The following switch attributes may be changed or selected using a wireless configuration tool:
    a. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
    b. Individual button function may be configured to Toggle, On only or Off only.
    c. Individual scenes may be locked to prevent unauthorized change.
    d. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
    e. Ramp rate may be adjusted for each dimmer switch.

f. Switch buttons may be bound to any load on a room controller and are not load type dependant; each button may be bound to multiple loads.

E. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101.

2.05 ROOM CONTROLLERS

A. Room Controllers automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will not have, dip switches, potentiometers or require special configuration. The control units will include the following features:
   a. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
   b. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
   c. Device Status LEDs to indicate:
   2. Data transmission
   3. Device has power
   4. Status for each load
   5. Configuration status
      a. Quick installation features including:
   6. Standard junction box mounting
   7. Quick low voltage connections using standard RJ-45 patch cable
      a. Plenum rated
      b. Manual override and LED indication for each load
      c. Dual voltage (120/277 VAC, 60 Hz)
      d. Zero cross circuitry for each load.

B. On/Off/Dimming enhanced Room Controllers shall include:
   a. Real time current monitoring
   b. One, two or three relay configuration
   c. Efficient 250 mA switching power supply
   d. Four RJ-45 DLM local network ports.
   e. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.
   f. The following dimming attributes may be changed or selected using a wireless configuration tool:
   g. Establish preset level for each load from 0-100%
   h. Set high and low trim for each load
   i. Set lamp burn in time for each load up to 100 hours
   j. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
   2. One relay configuration only
   3. Automatic-ON/OFF configuration
      a. WattStopper product numbers: LMRC-211, LRMC-212, LRMC-213, LMRC-221, LMRC-222, LMPL-201

2.06 DIGITAL PHOTOSENSORS

A. Digital photosensors work with room controllers to provide automatic switching or dimming daylight harvesting capabilities for any load type connected to a room controller. Closed loop photosensors measure the ambient light in the space and control a single lighting zone. Open

loop photosensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones. Photosensors shall be interchangeable without the need for rewiring.

B. Digital photosensors include the following features:
   a. An internal photodiode that measures only within the visible spectrum, and has a response curve that closely matches the photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.
   b. Sensor light level range shall be from 1-10,000 footcandles (fc).
   c. The capability of switching one-third, one-half or all lighting ON and OFF, or raising or lowering lighting levels, for each controlled zone, depending on the selection of room controller(s) and load binding to room controller(s).
   d. For switching daylight harvesting, the photosensor shall provide a deadband or a separation between the “ON Setpoint” and the “OFF Setpoint” that will prevent the lights from cycling after they turn off.
   e. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a user-selectable minimum level.
   f. Optional programmable wall switch override to allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise and lower lighting levels for a selected period of time or cycle of occupancy.
   g. Infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
   h. Red configuration LED that blinks to indicate data transmission.
   i. Blue status LED indicates test mode, override mode and load binding.
   j. Recessed switch to turn controlled load(s) ON and OFF.
   k. One RJ-45 port for connection to DLM local network.
   l. An adjustable head and a mounting bracket to accommodate multiple mounting methods and building materials. The photosensor may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox.

C. Closed loop digital photosensors include the following additional features:
   a. An internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from bright sources outside of this cone.
   b. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
   c. Automatically establishes setpoints following self-calibration.
   d. A sliding setpoint control algorithm for dimming daylight harvesting with a “Day Setpoint” and the “Night Setpoint” to prevent the lights from cycling.
   e. WattStopper Product Number: LMLS-400.

D. Open loop digital photosensors include the following additional features:
   a. An internal photodiode that measures light in a 60 degree angle cutting off the unwanted light from the interior of the room.
   b. Automatically establishes setpoints following calibration using a wireless configuration tool or a PC with appropriate software.
   c. A proportional control algorithm for dimming daylight harvesting with a “Setpoint” to be maintained during operation.
   d. WattStopper Product Number: LMLS-500.

2.07 EMERGENCY LIGHTING

A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency

lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:

a. 120/277 volts, 50/60 Hz., 20 amp ballast rating
b. Push to test button
c. Auxiliary contact for remote test or fire alarm system interface

B. WattStopper Product Numbers: ELCU-100, ELCU-200.

2.08 ROOM NETWORK (DLM LOCAL NETWORK)

A. The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building. Digital room devices connect to the network using CAT 5e cables with RJ-45 connectors which provide both data and power to room devices. Features of the DLM local network include:

a. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
b. Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.
c. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
d. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet (914.4 cm) from a sensor, wall switch or IR receiver.

2.09 LIGHTING CONTROL PANELS

A. Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:

B. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 □ 8 relays, 1 □ 24 relays and 6 four-pole contactors, or 1 □ 48 relays and 6 four-pole contactors.

C. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.

D. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:

a. Removable, plug-in terminal blocks with screwless connections for all low voltage terminations.
b. Individual terminal block, override pushbutton, and LED status light for each relay.
c. Direct wired switch inputs associated with each relay and group channel shall support two-wire, momentary or maintained contact switches.
d. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches, digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs, digital IO modules capable of receiving momentary or maintained contact closure inputs, digital photocell modules, and digital occupancy sensors.
e. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
f. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.

g. Group, channel, and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any group of relays can be associated with a channel for direct on/off control or pattern (scene) control via a simple programming sequence using the relay and channel override pushbuttons and LED displays for channels 1-9 or a handheld IR programmer for channels 1-99.
h. Relay group status for each channel shall be provided through red LED indicators for groups 1-9 and via BACnet for groups 1-99. Solid red indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
i. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
j. Electrical:

2. 30 amp ballast at 277V
3. 20 amp ballast at 347V
4. 20 amp tungsten at 120V
5. 30 amp resistive at 347V
6. 1.5 HP motor at 120V
7. 14,000 amp short circuit current rating (SCCR) at 347V
8. Relays shall be specifically UL listed for control of plug loads
   a. Mechanical:
9. Individually replaceable, ½" KO mounting with removable Class 2 wire harness.
10. Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
11. Dual line and load terminals each support two #14 □ #12 solid or stranded conductors.
12. Tested to 300,000 mechanical on/off cycles.
    a. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
13. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
14. Lighting control panels shall be WattStopper model LMCP8, LMCP24 or LMCP48 as shown on the plans.

2.10 BACNET® BASED DIGITAL COMMUNICATIONS

A. The lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 master/slave token passing-based using the BACnet® protocol.

B. The panel shall have provision for an individual BACnet device ID. The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.

C. The panel shall support MS/TP MAC addresses in the range of 0 □ 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.

D. Lighting control relays shall be controllable as binary output objects in the instance range of 1 □ 64. The state of each relay shall be readable and writable by the BAS via the object present value property.

E. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 □ 64.

F. The 99 channel groups associated with the panel shall be represented by binary value objects in the instance range of 201 □ 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a

channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.

G. Setup and commissioning of the panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
   a. Binary output objects in the instance range of 1 □ 64 (one per relay) for on/off control of relays.
   b. Binary value objects in the instance range of 1 □ 99 (one per channel) for normal hours/after hours schedule control.
   c. Binary input objects in the instance range of 1 □ 64 (one per relay) for reading true on/off state of the relays.
   d. Analog value objects in the instance range of 1 □ 64 (one per relay) shall assign relays to channel groups in the range of 1 □ 99.
   e. Analog value objects in the instance range of 101 □ 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute gracetime period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
   f. Analog value objects in the instance range of 201 □ 299 (one per channel) shall assign an after hours time delay value to the channel in the range of 1 □ 240 minutes.
   g. Multi-state value objects in the instance range of 1 □ 99 (one per channel) shall provide the state of the relays assigned to the channel. Valid states shall be ALL ON, MIXED, BLINK, and ALL OFF.

H. The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.

I. The BO and BV 1 □ 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (http://www.bacnet.org/Addenda/Add-135-2010aa.pdf)

J. Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.

K. Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.

L. Lighting control accessory devices connected to the panel shall be represented via BACnet objects including but not limited to the following:
   a. Digital occupancy sensor detection states shall be readable as BI objects ranging from BI1-96.
   b. Digital occupancy sensor configuration parameters shall each be accessible as BACnet objects when applicable to a given product.
   c. Occupancy sensor time delay in minutes shall be writeable via AV101-196.
   d. Occupancy sensor passive infrared (PIR) sensitivity percentage shall be writeable via AV201-296.
   e. Occupancy sensor ultrasonic (US) sensitivity percentage shall be writeable via AV301-396.
   f. Digital switch buttons shall be readable and writeable as BI objects ranging from BI101 – 9608.
   g. Digital daylight sensors foot-candle readings shall be readable as follows:

2. Analog 0-5V/0-10V sensors connected to a digital input module shall be represented as AI1-96.
    a. Digital closed loop sensors shall be represented as AI4001-4096.
    b. Digital open loop sensors shall be represented as AI5001-5096.
    c. Digital dual loop sensors shall be represented as follows:
3. The upward facing open loop sensor shall be represented as AI6001-6096.
4. The downward facing closed loop sensor shall be represented as AI6101-6196.
    a. Digital daylight sensor configuration shall be exposed as BACnet objects as follows:
5. Digital closed loop sensors shall be represented as follows:
    a. Daylight Sensor Day Setpoint (ftcd) AV4201-4296.
    b. Daylight Sensor Night Setpoint (ftcd) AV4301-4396.
    c. Daylight Sensor Off Setpoint Delay (minutes) AV4401-4496.
    d. Daylight Sensor On Setpoint (ftcd) AV4501-4596.
    e. Daylight Sensor Off Setpoint (ftcd) AV4601-4696.

2.11 USER INTERFACE

A. Each lighting control panel system shall be supplied with at least (1) handheld IR remote programming interface consisting of a keypad and associated OLED display screen. The user interface shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. The user interface shall have the following functions as a minimum:

B. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.

C. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.

D. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.

E. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.

F. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.

G. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minmum LAT, LON, DST zone, and an approximate city/state location.

H. An additional handheld IR remote may optionally be specified to be permanently mounted to the panel interior via a retractable anti-theft lanyard to allow for convenient programming of the panel while assuring that the handheld programmer is always present at that panel. An unlimited number of handheld IR remotes may also be purchased for facilities staff as seen fit by the end user's representative.

2.12 CONFIGURATIONS TOOLS

A. A configuration tool facilitates optional customization of DLM local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface.

B. Features and functionality of the wireless configuration tool shall include:

a. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet (914.4 cm).
b. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
c. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.
d. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
e. Temporarily adjust light level of any load(s)on the local network, and incorporate those levels in scene setting.
f. Adjust or fine-tune daylighting settings established during auto-commissioning, and input light level data to complete commissioning of open loop daylighting controls.

C. WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

2.13 NETWORK BRIDGE

A. The network bridge connects a DLM local network to a BACnet-compliant network for communication between rooms, panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. The network bridge shall use industry standard BACnet MS/TP network communication. Closed or proprietary network communication shall not be acceptable.

B. The network bridge may be incorporated directly into the room controller hardware (LMRC-3xx Room Controllers) or be provided as a separate module connected on the local network through an available RJ-45 port.

C. Provide Plug n' Go operation to automatically discover all room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.

D. The network bridge shall automatically create standard BACnet objects for selected room device parameters to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM room devices on each local network. Standard BACnet objects shall be provided as follows:
a. Read/write the normal or after hours schedule state for the room
b. Read the detection state of the occupancy sensor
c. Read/write the On/Off state of loads
d. Read/write the dimmed light level of loads
e. Read the button states of switches
f. Read total current in amps, and total power in watts through the room controller
g. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
h. Activate a preset scene for the room
i. Read/write daylight sensor fade time and say and night setpoints
j. Read the current light level, in footcandles, from interior and exterior photosensors and photocells
k. Set daylight sensor operating mode
l. Read/write wall switch lock status
m. WattStopper product numbers: LMBC-300

2.14 SEGMENT MANAGER

A. The Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall serve up a graphical user interface via a standard web browser. Each segment manager shall have support for one, two or three segment

networks as required and allow for control of a maximum of 40 local networks (rooms) and/or lighting control panels per segment network.

B. Operational features of the Segment Manager shall include the following:
    a. Connection to PC or LAN via standard Ethernet TCP/IP.
    b. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser.
    c. Log in security capable of restricting some users to view-only or other limited operations.
    d. Automatic discovery of all DLM devices on the segment network(s). Commissioning beyond activation of the discovery function shall not be required.
    e. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
    f. Ability to view and modify room device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation.
    g. Ability to set up schedules for rooms and panels. Schedules shall automatically set controlled zones or areas to either a normal hours or after hours mode of operation.
    h. Ability to group rooms and loads for common control by schedules, switches or network commands.
    i. Ability to monitor connected load current and display power consumption for areas equipped with room controllers incorporating the integral current monitoring feature.
    j. Provide seamless integration with the BAS via BACnet IP. Provide export table with available parameters.

PART 3 REALTIME COLOR GRAPHICS

3.01 SYSTEM DESCRIPTION

A. Color graphics screens shall allow a user to monitor and control the lighting control system through a graphical color interface. The system will control the room controllers in a real-time environment.

B. The application will provide a visual representation of the floor plan, drawn to scale, with each fixture displayed on screen. Fixtures can automatically indicate the relay controlling them on screen.
    a. Graphic Screen Generation
    2. The General Contractor shall provide as built CAD floor plans to the manufacturer for generation of graphic screens.
    3. As-Built relay panel and reflected ceiling documentation must be provided to the manufacturer before graphic screen development can begin. Graphic screens will be provided and demonstrated to the owner within 90 days of receiving as built CAD files.

DISTRICT WIDE HOME SCREEN

LINKS TO ALL EXISTING WATTSTOPPER SCHOOLS IN THE DISTRICT

SCHOOL HOME SCREEN
- **SCHOOL RENDERING**
- **DAY/ TIME**
- **SCHEDULE FOR THAT DAY**
- **EXTERIOR FC READING**
- **CURRENT LIGHTING WATTS PER FT**
- **PLUG LOAD WATTS PER FT**

QUICK ACCESS SYSTEM TREE
- **LINKS**
- **365 DAY SCHEDULER**

SITE PLAN
- **ALL EXTERIOR LIGHTING SHOWN ON/ OFF**

SCREENS PER FLOOR
- **FOR NAVIGATION AND SHOWING LIGHTING ON/OFF**

DETAIL SCREEN PER ARCHITECTURAL AREA

ROOM OCCUPANCY (ROOM SHADED GREEN)
- **LIGHTING STATES (3 ZONES WITH OVERRIDE)**
- **REAL TIME WATTAGE FOR LIGHTING**
- **REAL TIME WATTAGE FOR PLUG LOAD**
- **REAL TIME PHOTOCELL FOOTCANDLE READING IF APPLICABLE**

ALARMS

REPORTS

A. WattStopper Product Numbers: LMSM-6E.

PART 4 EXECUTION

9.01 INSTALLATION

A. Contractor shall provide to the manufacturer all quantities for system including but not limited to relays, room controllers, relay panels, plug load controllers, switches, sensors and wire lengths and configurations for both network and device cable at least 1 week before bid.

B. When using wire for connections other than the DLM local network (Cat 5e with RJ-45 connectors), provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements

C. All MSTP network and Cat 5e low voltage wiring must have “WattStopper” printed on the wire jacket. Any cable substitutions shall be removed and replaced at the contractor’s expense.

D. All MSTP network terminations shall utilize wire ferrules for terminations and MSTP network manufacturer’s instructions. Any network deficiencies shall be repaired at the contractor’s expense.

E. Electrical contractor must provide a detailed as-built plan in CAD showing MSTP network cable routing and network bridge serial numbers to the manufacturer at least 2 weeks prior to factory commissioning Install the work of this Section in accordance with manufacturer’s printed instructions unless otherwise indicated.

9.02 FACTORY COMMISSIONING (OPTIONAL).

A. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.

B. The factory commissioning shall include the following services. Programming of all button stations, configuration of all occupancy sensors and photocells. Verification of a complete and working system including MSTP network status. Provide written or computer-generated

documentation on the commissioning of the system including room by room description including:

a. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
b. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
c. Load Parameters (e.g. blink warning, etc.)

C. The lighting control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer's instructions. Functional testing shall be in accordance with IECC 2015 Sections C408.3.1.1 through C408.3.1.3 for the applicable control type. Provide a detailed report to the Architect / Commissioning Agent.

D. The electrical contractor shall request factory commissioning by submitting a startup request form at least (4) weeks before startup is required.

E. The electrical contractor shall provide at least (1) journeyman electrician, familiar with the installation of the system, dedicated to assisting the factory start-up technician for the entire duration of the commissioning process.

F. Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

9.03 RE-COMMISSIONING – AFTER 90 DAYS FROM OCCUPANCY THE FACTORY AUTHORIZED REPRESENTATIVE AND ELECTRICAL CONTRACTOR SHALL RE-CALIBRATE ALL SENSOR TIME DELAYS AND SENSITIVITIES TO MEET THE OWNER'S PROJECT REQUIREMENTS. PROVIDE A DETAILED REPORT TO THE ARCHITECT / OWNER OF RE-COMMISSIONING ACTIVITY

END OF SECTION

SECTION 265600
EXTERIOR LIGHTING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. Exterior luminaries with lamps and ballasts.
   2. Luminaire-mounted photoelectric relays.
   3. Poles and accessories.

B. Related Sections include the following:
   1. List below only products that the reader might expect to find in this Section but are specified elsewhere.
   2. Division 26 Section "Interior Lighting" for exterior luminaries normally mounted on exterior surfaces of buildings.

1.03 DEFINITIONS

A. Retain abbreviations and terms that remain after this Section has been edited.

B. CRI: Color-rendering index.

C. LED: Light Emitting Diode.

D. Luminaire: Complete lighting fixture, including ballast housing if provided.

E. Pole: Luminaire support structure, including tower used for large area illumination.

F. Standard: Same definition as "Pole" above.

1.04 REFERENCE STANDARDS

A. AAMA 611 - Specification for Anodized Architectural Aluminum; 2026.

B. AASHTO LTS - Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals; 2013, with Editorial Revision (2025).

C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.

E. IEEE C2 - National Electrical Safety Code(R) (NESC(R)); 2023.

F. IESNA RP-8 - Roadway Lighting; 2014.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).

I. SSPC-SP 5/NACE No.1 - White Metal Blast Cleaning; 2026.

J. UL 773 - Plug-in, Locking Type Photocontrols for Use with Area Lighting; Current Edition, Including All Revisions.

K. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.

L. UL 1598 - Luminaires; Current Edition, Including All Revisions.

1.05 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-.

B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4.

C. Ice Load: Load of 3 lbf/sq. ft. applied as stated in AASHTO LTS-4.

D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.
   1. Wind speed for calculating wind load for poles 50 feet (1524 cm) or less in height is 110 mph.

1.06 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
   2. Details of attaching luminaries and accessories.
   3. Details of installation and construction.
   4. Luminaire materials.
   5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
      a. For indicated luminaries, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaries shall be certified by manufacturer.
      b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   6. Photoelectric relays (photocell).
   7. Ballasts, including energy-efficiency data.
   8. Lamps, including life, output, and energy-efficiency data.
   9. Materials, dimensions, and finishes of poles.
   10. Means of attaching luminaries to supports, and indication that attachment is suitable for components involved.
   11. Anchor bolts for poles.
   12. Retain subparagraph below if manufactured pole foundations, including screw foundations, are indicated.
   13. Manufactured pole foundations.

B. Shop Drawings:
   1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
   2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
   3. Wiring Diagrams: Power and control wiring.

C. Samples for Verification: For products designated for sample submission in Exterior Lighting Device Schedule. Each sample shall include lamps and ballasts.

D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

E. Qualification Data: For agencies providing photometric data for lighting fixtures.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For luminaries and poles to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.07 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C2, "National Electrical Safety Code."

D. Comply with NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches (304.8 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.09 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
   1. Warranty Period for Luminaries: Five years from date of Substantial Completion.
   2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
   3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
   4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
   5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Ballasts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
   4. Globes and Guards: 10 for every 20 of each type and rating installed. Furnish at least one of each type.
   5. At a minimum, the electrical contractor shall provide two (2) cases of fluorescent lamps and one (1) case of electronic ballasts with other attic stock items upon project completion

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Approved Manufacturers: The following manufacturers and their subsidiaries are approved:
   1. Phillips / Signify

2. Eaton
3. Acuity
4. Hubbell

B. Substitutions:
1. Procedure as indicated in 26 05 00-1.3(B)

C. Contractor shall furnish full photometric calculation study for all affected areas for fixtures other than basis-of-design as indicated on Drawings.

2.02 LUMINAIRES, GENERAL REQUIREMENTS

A. Refer to Drawings for basis-of-design Light Fixture Schedule for all characteristics.

B. Luminaries shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

C. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaries.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

F. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaries.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

H. Exposed Hardware Material: Stainless steel.

I. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

J. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

K. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

L. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

M. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

N. Factory-Applied Finish for Steel Luminaries: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No.1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
3. Retain one of three subparagraphs below.

a. Color: As selected by Architect from manufacturer's full range.

O. Factory-Applied Finish for Aluminum Luminaries: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Retain one of three subparagraphs and associated subparagraph below or revise to suit Project.
3. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
4. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0 inch (0.02 mm) or thicker) complying with AAMA 611.
5. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0 inch (0.02 mm) or thicker) complying with AAMA 611.
a. Color: Dark bronze.

2.03 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS (PHOTOCELLS)

A. Comply with UL 773 or UL 773A.

B. Parking lot lights shall be controlled by photo cells or the Building Automation System.

C. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay.
1. Relay with locking-type receptacle shall comply with NEMA C136.10.
2. Adjustable window slide for adjusting on-off set points.

2.04 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-4.
1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaries and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM A123/A123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.05 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317158.96 kPa); 1-piece construction up to 40 feet (1219.2 cm) in height with access hand-hole in pole wall.
   1. Shape: Square, tapered.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
   3. Minimum Tubing Thickness: 7 gauge.

B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole. Quantity and orientation as indicated on Drawings.

C. Brackets for Luminaries: Detachable, cantilever, without under-brace.
   1. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
   2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
   3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaries and brackets indicated, and securely fastened to pole top.

E. Intermediate Hand-hole and Cable Support: Weather-tight, hand-hole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.

F. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through hand-hole.

G. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

H. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.

I. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

J. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A123/A123M.

K. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No.1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
   2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
   3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: As indicated by manufacturer's designations

PART 3 EXECUTION

3.01 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.
   1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaries that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.02 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaries and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches (1524 mm).
   2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (304.8 cm).
   3. Trees: 15 feet (457.2 cm).

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.
   1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   2. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
   3. Install base covers, unless otherwise indicated.
   4. Use a short piece of 1/2-inch-diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
   1. Dig holes large enough to permit use of tampers in the full depth of hole.
   2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

F. Embedded Poles with Concrete Backfill: Set poles in augured holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
   1. Make holes 6 inches (152.4 mm) in diameter larger than pole diameter.
   2. Fill augured hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi (20684.28 kPa) at 28 days, and finish in a dome above finished grade.
   3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
   4. Cure concrete a minimum of 72 hours before performing work on pole.

G. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25.4 mm) below top of concrete slab.

H. Raise and set poles using web fabric slings (not chain or cable).

3.03 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches (101.6 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.04 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches (101.6 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.05 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.06 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole, unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.07 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaries and energizing circuits with normal power source.
   1. Verify operation of photoelectric controls.

C. Illumination Tests:
   1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
      a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting."
      b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
      c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
      d. IESNA LM-64, "Photometric Measurements of Parking Areas."
      e. IESNA LM-72, "Directional Positioning of Photometric Data."

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 270000
COMMUNICATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. This section includes general design requirements, administration topics, and installation for communications systems.

1.02 SYSTEM DESCRIPTION

A. The objective of this project is to provide a complete communications cabling infrastructure system installation including, but not limited to: communications backbone and riser cabling, communications horizontal cabling system, communications equipment room fittings, communications pathway and management systems, testing, labelling and other items/materials, as specified in drawings, these specifications, and contract documents.

B. Related Sections
   1. Section 270526 Grounding and Bonding for Communications Systems
   2. Section 270528 Interior Pathways for Communications Systems
   3. Section 270543 Exterior Pathway for Communications Systems
   4. Section 270553 Identification for Communications Systems
   5. Section 271100 Communications Equipment Room Fittings
   6. Section 271300 Communications Backbone Cabling
   7. Section 271500 Communications Horizontal Cabling
   8. Section 272100 Data Communication Network Equipment
   9. Section 274116 Integrated Audio-Video Systems and Equipment
   10. Section 274133 Master Antenna Television Systems
   11. Section 275113 Paging System
   12. Section 275319 Emergency Responder Radio Communications System

1.03 REFERENCES AND RELATED DOCUMENTS

A. Drawings and General provisions of the contract, including Uniform General Conditions, Supplementary General Conditions, Architectural plans and specifications, requirements of Division 1, Electrical, Mechanical, Plumbing, Audio-Visual, Security and Communications specifications and plans, and the publications listed below apply to the Communications section, are incorporated into this specification by reference, and shall be considered a part of this section.

B. Reference to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean reference to the latest printed edition of each in effect at the date of contract.

C. The Contractor shall read all sections in their entirety and apply them as appropriate for work in this section.

D. Conflicts
   1. Drawings and specifications are to be used in conjunction with one another and to supplement one another.
   2. In general, the specifications determine the nature and quality of the materials and tests, and the drawings establish the quantities, details, and give
      a. characteristics of performance that should be adhered to during the installation of the communications system components.
   3. If there is an apparent conflict between the drawings and specifications, or between specification sections, the items with the greater quantity and/or quality shall be estimated and installed.
   4. Clarification with OWNER and IT Consultant about these items shall be made in writing prior to procurement and installation.

E. Codes and Standards
   1. American National Standards Institute/Telecommunications Industry Association (ANSI/TIA)
      a. ANSI/TIA-568-C.0 "Generic Telecommunications Cabling for Customer Premises"
      b. ANSI/TIA-568-C.1 "Commercial Building Telecommunications Cabling Standard"
      c. ANSI/TIA-568-C.2 "Balanced Twisted-Pair Telecommunication Cabling and Components Standard"
      d. ANSI/TIA-568-C.3 "Optical Fiber Cabling Components Standard"
      e. ANSI/TIA-568-C.4 "Broadband Coaxial Cabling and Components Standard"
      f. ANSI/TIA-569-C "Telecommunications Pathways and Spaces"
      g. ANSI/TIA-606-B "Administration Standard for Commercial Telecommunications Infrastructure"
      h. ANSI/TIA-607-B "Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications"
      i. ANSI/TIA-758-B "Customer-Owned Outside Plant Telecommunications Infrastructure Standard"
      j. ANSI/TIA-862-A “Building Automation Systems Cabling Standard”
      k. ANSI/TIA-942-A: “Telecommunications Infrastructure Standard for Data Centers”
      l. ANSI/TIA-1152: “Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling”
   2. American National Standards Institute (ANSI)
      a. ANSI C80.1 Electrical rigid steel conduit (ersc)
   3. American Society for Testing Materials (ASTM)
      a. ASTM A123/A123M-13 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
      b. ASTM A510/A510M-13 Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel
      c. ASTM A653/A653M-13 Standard Specification for Steel Sheet, Zinc- Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
      d. ASTM B3-13 Standard Specification for Soft or Annealed Copper Wire
      e. ASTM B8-11 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
      f. ASTM B33-10 Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
      g. ASTM B633-13 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
      h. ASTM B653/B653M-11 Standard Specification for Seamless and Welded Zirconium and Zirconium Alloy Welding Fittings
   4. BICSI
      a. BICSI Outside Plant Design Reference Manual
      b. BICSI Telecommunications Distribution Methods Manual (TDMM)
   5. Federal Specifications (FS)
      a. FS W-C-58C Conduit Outlet Boxes, Bodies Aluminum and Malleable Iron
      b. FS W-C-1094 Conduit and Conduit Fittings Plastic, Rigid
      c. FS WW-C-566C Flexible Metal Conduit
      d. FS WW-C-581D Coatings on Steel Conduit
   6. Institute of Electrical and Electronic Engineers (IEEE)
      a. IEEE 142-1991 Recommended Practice for Grounding of Industrial and Commercial Power Systems
      b. IEEE 1100-2005 IEEE Recommended Practice for Powering and Grounding Electronic Equipment
   7. National Electrical Code (NEC)

a. NEC Article 250 - Grounding and Bonding
b. NEC Chapter 8 - Communications Systems

8. National Electrical Manufacturers Association (NEMA)
   a. NEMA RN1 Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
   b. NEMA TC 2 Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
   c. NEMA TC 3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
   d. NEMA VE 1 - Metal Cable Tray Systems
   e. NEMA VE 2 - Cable Tray Installation Guidelines
9. Underwriters' Laboratories (UL)
   a. UL Cable Certification and Follow-Up Program
   b. UL 6: Electrical Rigid Metal Conduit - Steel
   c. UL 83: Thermoplastic-Insulated Wires and Cables
   d. UL 467: Grounding and Bonding Equipment
   e. UL 514B: Conduit, Tubing, and Cable Fittings
   f. UL 651: Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
   g. UL 651A: Schedule 40 and 80 High Density Polyethylene (HDPE)
      1) Conduit
   h. UL 1666: Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
10. Local, county, state and federal regulations and codes in effect as of date of installation.
11. Equipment of foreign manufacture must meet U.S. codes and standards.
    a. It shall be indicated in the proposal the components that may be of foreign manufacture, if any, and the country of origin.

1.04 ABBREVIATIONS, ACRONYMS AND DEFINITIONS

A. Abbreviations and Acronyms
1. ACD Automatic Call Distribution
2. AFF Above Finished Floor
3. ANSI American National Standards Institute
4. ATM Asynchronous Transfer Mode
5. AWG American Wire Gauge
6. BD Building Distributor
7. BICSI Building Industry Consulting Services International
8. CAT5 Category 5 Copper Cable
9. CAT5e Category 5e Copper Cable
10. CAT6 Category 6 Copper Cable
11. CAT6A Category 6A Copper Cable
12. CDDI Copper Distributed Data Interface
13. CMP Communications Multipurpose Plenum: cable rating
14. CMR Communications Multipurpose Riser: cable rating
15. ELFEXT Equal-Level Far-End Crosstalk
16. FD Floor Distributors
17. FEXT Far End Crosstalk
18. Gbps Gigabits per second
19. HVAC Heating, Ventilation, and Air Conditioning
20. IDF Intermediate Distribution Frame - Termination frames, relay racks, and cable management
21. IEEE The Institute of Electrical and Electronics Engineers
22. IM Information Management

23. ISDN Integrated Services Digital Network
24. ISO International Organization for Standardization
25. LAN Local Area Network
26. Mbps Megabits per second
27. MDF Main Distribution Frame, consisting of carrier entrance rooms and head- end
28. MMF Multi-mode fiber optics, 50 or 62.5 micron laser optimized core
29. MIMO Multiple-In and Multiple-Out
30. Multi-path The possible multiple routes of a single source of RF energy due to reflection, refraction, or diffraction.
31. MUTOA Multi-User Telecommunications Outlet Assembly
32. NEC National Electrical Code
33. NEMA National Electrical Manufacturing Association
34. NEXT Near End Cross Talk
35. NRTL Nationally Recognized Testing Laboratories
36. OSHA Occupational Safety and Health Act
37. PBB Primary Bonding Busbar (was called TMGB)
38. PBX Private Branch Exchange: telephone switch
39. PDS Premises Distribution Systems (See SCS.)
40. PoE Power over Ethernet (IEEE 802.3af)
41. POP Point of Presence
42. PSACR Power Sum Attenuation-to-Crosstalk Ratio
43. PSAFEXT Power Sum Alien Far-End Crosstalk
44. PSAELFEXT Power Sum Alien Equal Level Far-End Crosstalk
45. PSANEXT Power Sum Alien Near-End Crosstalk
46. PSELFEXT Power Sum Equal Level Far-End Crosstalk
47. PSNEXT Power Sum Near-End Crosstalk
48. RF Radio Frequency: Signal generated by a radio transmitter and sent out through an antenna. The frequency of the transmission is described in terms of the number of cycles per second or Hertz (Hz).
49. SBB Secondary Bonding Busbar (was called TGB)
50. SCC Security Command Center
51. SCS Structured Cabling System, or Structure Connectivity System; a complete cabling system
52. SFF Small Form Factor
53. SFP Small Form-Factor Pluggable – Hot-pluggable transceiver used for both telecommunication and data communication applications. Comes in both copper and fiber.
54. SMF Single-mode fiber optics, 8.3 micron core
55. SNMP Simple Network Management Protocol
56. TC Telecommunications Closet
57. TE Telecommunications Enclosure
58. TEF Telecommunications Entrance Facility
59. TIA Telecommunications Industry Association
60. TR Telecommunications Room
61. TO Telecommunications Outlet
62. TWC Time Warner Cable - Owner
63. UPS Uninterruptible Power Supply
64. UTP Unshielded Twisted Pair
65. VoIP Voice over Internet Protocol
66. WAO Work Area Outlet
67. WAN Wide Area Network
68. WAP Wireless Application Protocol
69. WPA/WPA2 WiFi Protected Access / WiFi Protected Access II – IEEE 802.11i-2004

B. Definitions
   1. Access Floor - A floor system that has removable floor panels.
   2. Building Backbone Cabling – Cabling used to connect Floor Distributors (FD) or other local collection points to the Building Distributor (BD). Building backbone cabling typically carries aggregate traffic and, as such, impacts multiple network devices and users. Building backbone cabling may include either fiber optic or copper cabling or both.
   3. Building Distributor (BD) – Termination point from which all building backbone cabling emanates and interconnection point for the network backbone. Commonly referred to as BDF in Americas, Main Comms Room in EMEA and Communication Room, IT Lab or IT Room in AsiaPac. Referred to as BD in international and European industry standards and Intermediate Cross-connect (IC) in American industry standards. There is one BD for each building and it feeds all FD's in the same building. The BD should be located so that all FD's served are within 300 cable meters (984 cable feet). All BD's are linked to the
   4. Campus Backbone Cabling – Cabling used to connect Building Distributors (BD) or other key network segments to the Campus Distributor (CD). With rare exceptions, campus backbone cabling carries aggregate traffic and typically impacts entire buildings worth of network devices and users and, as such, link redundancy with diverse routing is highly recommended. Campus backbone cabling almost exclusively consists of fiber optic cabling. Copper cabling may be used in short-distance (??? 90m) applications. In such cases, lightning protection will usually be required by code.
   5. Campus Distributor (CD) – Termination point from which all campus backbone cabling emanates and highest-level interconnection point for the network backbone. Commonly referred to as NOC in Americas and Main Comms Room in EMEA. Referred to as CD in international and European industry standards and Main Cross-connect (MC) in American industry standards. On smaller campuses, there is one CD for the campus. On larger campuses there might be several CD's with each CD serving several buildings. Besides linking to each of the BD's it serves, the CD is also the network interconnection point for data center links and links to service providers.
   6. Category 3 (Cat 3) – A category of transmission performance, defined in TIA standards, that specifies electrical properties up to 10 MHz. Cat 3 is the minimum performance grade permissible and is used typically for analog voice distribution.
   7. Category 5e (Cat 5e) / Class D – A category/class of transmission performance that specifies electrical properties up to 155.5 MHz. Capable of supporting copper-based, four-pair Gigabit Ethernet (IEEE 802.3ab 1000BASE-T) applications. Category 5e is defined in TIA 568B.2 standard. Class D is defined in the ISO 11801 standard.
   8. Category 6 (Cat 6) / Class E – A category/class of transmission performance that specifies electrical properties up to 250 MHz. Refer to the TIA 568B family of standards for more information on Category 6 and ISO/IEC 11801 for more information on Class E requirements. Also refer to CENELEC EN50173.
   9. Category 6A (Cat 6) / Class EA– A category/class of transmission performance that specifies electrical properties up to 500 MHz and capable of supporting data applications operating at 10Gbps. Refer to the TIA 568B family of standards for more information on Category 6 and ISO/IEC 11801 for more information on Class EA requirements.
   10. Certification – The testing and documentation of the transmission performance (e.g., Category 5e / Class D) of a permanent link or channel, based on sweep frequency (where applicable) testing of numerous parameters with results compared to a range of acceptable values. This project requires 100% certification (with documentation) of all permanent link cabling at the time of
       a. installation. Channel certification is optional and is the responsibility of the group using the channel.
   11. Channel – The entire physical pathway between active equipment ports, inclusive of all patch cords, patch panels, jacks and cabling segments.
   12. Class C – A category of transmission performance, defined in ISO and EN standards, that specifies electrical properties up to 16 MHz

13. Conduit - A raceway of circular cross-section.
14. Entrance Facility (EF) – Termination point of service provider cables that have entered the building and location of service demarcation point (MPOE) and interconnection point to the network. Commonly referred to as Telco Room in Americas, POP Room in EMEA and Building Entrance in AsiaPac. Referred to as Building Entrance Facility in international and European industry standards and Entrance Facility (EF) in American industry standards. The EF is linked to the CD, where present, or to the BD.
15. Floor Distributor (FD) – Termination point for horizontal cabling and interconnection point for network access. Commonly referred to as IDF in Americas and AsiaPac and as Sub Comms Room in EMEA. Referred to as Floor Distributor (FD) in international and European industry standards and Horizontal Cross-connect (HC) - FD quantities and locations are determined by building size and geometry so that all points served are within 90 cable meters (295 cable feet) of an FD. The FD feeds all Telecommunications Outlets (TO's) in its service zone. All FD's in a building are linked to the building's Building Distributor (BD) via backbone cabling.
16. Horizontal Cabling – Cabling used to connect individual work area outlets to local Floor Distributors (FD) or other collection points. Unlike backbone cabling, horizontal cabling does not typically carry aggregate traffic and, as such, impacts only single network devices or users. In buildings, horizontal cabling almost exclusively consists of copper cabling. Fiber optic cabling may be used where situations dictate but, unlike horizontal copper cabling, horizontal fiber optic cabling is not installed in advance as default building facilities. At this writing, horizontal copper cabling in many networks is capable of supporting Gigabit (1Gb/s) Ethernet applications as well as other applications of similar bandwidth.
17. Permanent Link – A stationary cabling segment, consisting of the permanently installed cable and the permanently affixed jack at both ends (typically at the outlet faceplate and closet patch panel, or on a patch panel on both ends). The concept is based on the assumption that, while patch cords might be disconnected or moved over time, the permanent cable and jacks will not be disturbed, and the electrical characteristics of the permanent link will remain unaltered.
18. Plenum - A space within the building designed for the movement of environmental air; i.e., a space above a suspended ceiling or below an access floor.
19. Raceway - Any channel designed for holding wires or cables; i.e. conduit, electrical metal tubing, busways, wireways, ventilated flexible cableway.
20. Spine – also called a backbone, the main communications cables in an IDF.
21. Provide: Where the word "provide" is used, the word is understood to mean, "the Contractor shall furnish and install" the equipment, tests, inspections, etc. referenced.
22. Related Work: The sections referenced under the article RELATED SECTIONS are understood to include provisions that directly affect the work being specified in the section where the RELATED SECTIONS article occurs.
23. Concealed: Where the word "concealed" is used in conjunction with raceways, equipment and the like, the word is understood to mean hidden from sight as in chases, furred spaces or suspended ceilings.
24. Exposed: Where the word "exposed" is used, the word is understood to mean open to view.

1.05 QUALITY ASSURANCE

A. Communications Contractor shall have a complete working knowledge of low voltage communications cabling applications such as, but not limited to data, voice and video network systems.

B. Communications Contractor shall have installed similar-sized systems in at least ten (10) other projects in the last five (5) years prior to this bid and be regularly engaged in the business of installation of the types of systems specified in this document.

C. Communications Contractor and individual installation crew members shall be experienced and qualified to perform the work specified herein at time of bid submission. All onsite supervision personnel that will be assigned to this project shall be listed in the Pre-Installation Submittal.
   1. 80% shall have a minimum of three (3) years of experience in the installation of the types of systems, equipment, and cables specified in this document prior to this bid.
   2. All installation team members must demonstrate knowledge and compliance with all applicable methods, standards, and codes.
   3. All members of the installation team shall be certified by the Structured Cabling System Assurance Warranty provider as having completed the necessary training to complete their part of the installation and capable of an installation that falls under manufacturer's guidelines necessary to obtain the Manufacturer's System Assurance Warranty.
   4. Any personnel substitutions shall be noted in writing to HARRIS COUNTY IT.

D. A BICSI RCDD shall supervise and approve all on-site work as a recognized member of the Contractor's installation team.

E. Refer also to General Conditions.

1.06 COMPLETENESS OF WORK

A. Complete and usable work: The contractor is responsible for providing complete and usable work according to contract documents. All materials and equipment shall be provided with all accessories and additional work required for field conditions, as well as additional work and accessories required for complete, usable, and fully functional construction and systems, even if not explicitly specified or indicated. Telecommunications system in this Contract shall be provided as complete and operable systems in full compliance with requirements on drawings and specification requirements. Drawings are diagrammatic and specifications are performance-based, and Contractor shall provide all work required to comply with drawings and specifications, even if not explicitly indicated or specified. Contractor shall be responsible for coordinating installation of electrical systems with all field conditions and work of other trades. Minimum clearances and work required for compliance with NFPA 70, National Electrical Code® (NEC®), and manufacturer's instructions shall be provided. Comply with additional requirements indicated for access and clearances. Contractor shall verify all field conditions and dimensions that affect selection and provision of materials and equipment, and shall provide any disassembly, reassembly, relocation, demolition, cutting and patching required to provide work specified or indicated, including relocation and reinstallation of existing wiring and equipment. Contractor shall protect from damage
   1. resulting from Contractor's operations existing facility, equipment, and wiring. Extra charges for completion and contract time extension will not be allowed because of field conditions or additional work required for complete and usable construction and systems. Comply with additional requirements indicated for access and clearances.

B. Drawings and specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Except where explicitly modified by a specific notation to contrary, it shall be understood that indication or description of any item, in drawings or specifications or both, carries with it instruction to furnish and install item, provided complete.

C. Terms: As used in this specification, provide means furnish and install. Furnish means "to purchase and deliver to project site complete with every necessary appurtenance and support," and install means "to unload at delivery point at site and perform every operation necessary to establish secure mounting and correct operation at proper location in project."

D. Authority approvals: Give notices, file plans, obtain permits and licenses, pay fees, and obtain necessary approvals from authorities that have jurisdiction as required to perform work according to all legal requirements and with Specifications, Drawings, Addenda and Change Orders, all of which are part of Contract Documents.

E. Supplementary items: Provide supplementary or miscellaneous items, appurtenances, devices and materials necessary for a sound, secure and complete installation. Examine project drawings and other Sections of specifications for requirements that affect work of this section. Completely coordinate work of this section with work of other Sections and provide a complete and fully functional installation. Refer to all other drawings and other specifications sections that indicate types of construction in which work shall be installed and work of other sections with which work of this section must be coordinated

F. Quantities: Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.

1.07 CONTRACTOR REQUIREMENTS

A. In order to accomplish the conditions of this agreement, the Contractor shall perform the specific duties listed herein.

B. Contractor shall provide and pay for all labor, supervision, tools, equipment, test equipment, tests and services to provide and install a complete communications cabling infrastructure system. Pay all required sales, gross receipts, and other taxes.

C. Insurance
   1. The Contractor shall procure, submit for review, and maintain for the duration of this agreement, insurance against claims for injuries to persons or damages to property which may arise from, or in connection with, the performance of work hereunder by the Contractor, his agents, representatives, employees or subcontractor. The Contractor shall pay the cost of such insurance.
   2. OWNER, its directors, officers, representatives, agents and employees, respectively, shall have no responsibility to the Contractor with respect to any insurance in accordance with the provisions set forth herein.

D. Regulatory Requirements
   1. Communications Contractor shall supply all city, county, and state telecommunication cabling permits required by Authority Having Jurisdiction (AHJ).
   2. Communications Contractor shall be licensed and/or bonded as required for telecommunications/low voltage cabling systems.

E. Privacy and Confidentiality
   1. The Contractor will respect and protect the privacy and confidentiality of OWNER, its employees, processes, products, and intellectual property to extent necessary, consistent with the legal responsibilities of OWNER policies.
   2. Contractors shall sign a non-disclosure agreement and abide by the requirements to keep confidential all information concerning bid documents and this project.

F. Use of Subcontractors
   1. Successful bidder shall inform OWNER’s contact and General Contractor in writing about the intention to use Subcontractors and the scope of work for which they are being hired.
   2. OWNER or OWNER’s designated contact must approve the use of Subcontractors in writing prior to the Subcontractor’s hiring and start of any work.

G. The Contractor’s designated Project Manager will be recognized as the single point of contact. The Project manager shall oversee all work performed to ensure compliance with specifications as outlined in bid documents (which includes all specifications, references, and drawings) to ensure a quality installation and attend project meetings with the telecommunication Consultant, HARRIS COUNTY IT and others.

H. Coordination
   1. Coordinate installation work with other trades (examples include ceiling grid contractors, HVAC and sheet metal contractors, etc.) to resolve procedures and installation placement for cable trays and cable bundle pathways.

2. The goal of this coordination will be to establish priority pathways for critical data/voice network cable infrastructure, materials, associated hardware, as well as mitigate delays to the project and to allow service access for communications and HVAC components.
3. Exchange information and agree on details of equipment arrangements and installation interfaces.
4. Coordinate with electrical contractors and plan for the pathway routes used communications cabling to minimize cable lengths. Report any potential over distance cable runs for approval before pulling the cables.
5. Record agreements with other trades and distribute record to other participants, HARRIS COUNTY IT and telecommunication Consultant.

1.08 PRE-INSTALLATION MEETINGS

A. Communications Contractor shall attend and/or arrange a scheduled pre-installation conference prior to beginning any work of this section. This venue is to ask and clarify questions in writing with Consultant, project manager, and OWNER IT representative.

B. Agenda
1. Safety
2. Work to be performed
3. Scheduling
4. Coordination
5. Submittals (Product Data, Shop Drawings, Test Report, As-built Drawings, Warranty)
6. Construction Inspection
7. Final Acceptance

C. Attendance
1. Communications project manager/supervisor shall attend meetings arranged by General Contractor, Owner PM, OWNER's IT representatives, and other parties affected by work of this document.
2. All individuals who will serve in an on-site supervisory capacity, including project managers, site supervisors, and lead installers, shall be required to attend the pre-installation conference. Individuals who do not attend the conference will not be permitted to supervise the installation and testing of communications cables on the project.

1.09 CONTRACT ADMINISTRATION

A. IT Consultant shall perform site visits and provide job field reports upon inspection of Contractor's installation, materials, supporting hardware, coordination with other trades and progress to schedule to the client.

B. Construction team shall coordinate with Owner IT representatives and provide advanced notice (minimum of one week) for the inspection of all communications-related items (pathway, cabling, racks, etc.) before they are covered (underground, in-wall, above ceiling, etc.).

C. Job Field Report outline:
1. General: The general installation progress in relation to scheduled work made by the Contractor up to that date.
2. Deficiencies and/or Items of Note: observations of the cable installation that may require corrective action by the Contractor.

D. Contractor shall correct all deficiencies in the Job Field Report and provide photo evidence before they are covered.

1.10 POST INSTALLATION MEETINGS

A. At the time of substantial completion, the contractor shall call and arrange for a post installation meeting to present and review all submittal documents to include but not be limited to As-Built Drawings, Test reports, Warranty paperwork, etc.

B. Attendees shall include

1. Communications Contractor
2. Project Manager/OWNER IT Representative
3. General Contractor
4. IT Consultant.
5. Other trades that the GC deems appropriate.

C. At this meeting the Communications Contractor shall present and explain all documentation.

D. Any discrepancies or deviations noted by and agreed to by participants shall be remedied by the Communications Contractor and resubmitted within one (1) week of the meeting.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Coordination with delivery companies, drivers, site address, and contact person(s) will be the responsibility of the Contractor.

B. Communications Contractor requirements:
1. Be responsible for prompt material deliveries to meet contracted completion date.
2. Coordinate deliveries and submittals with the General Contractor to ensure a timely installation.
3. No equipment materials shall be delivered to the job site more than three weeks prior to the commencement of its installation.
4. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
5. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.
6. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants.
7. Equipment damaged prior to system acceptance shall be replaced at no cost to OWNER.
8. Contractor shall be responsible for all handling and control of equipment. Contractor is liable for any material loss due to delivery and storage problems.

C. OWNER/General Contractor shall provide the security requirements for Contractor to follow.

1.12 PROJECT/SITE CONDITIONS

A. For all environmental recommendations, refer to master Architectural section.

B. For all security recommendations, refer to related consultant sections.

C. Contractor shall provide daily a clean work environment that is free from trash/rubbish accumulated during and after cabling installation.

D. Contractor shall keep all liquids (drinks, sodas, etc.) away from finished spaces. If any liquid or other detriment (cuts, soils, stains, etc.) damages any finishes, Contractor shall provide professional services to clean or repair scratched/soiled finishes, at Contractor's expense.

E. Damage by Communications Contractor to the work of others will be remedied at the Contractor's expense in a timely manner.

1.13 WARRANTY

A. The Contractor shall be a certified Manufacturer's Value Added Reseller (VAR) and/or Authorized Installer and provide an end-to-end product warranty, adhere to the industry standard engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this project.

B. Contractor shall coordinate with manufacturer for warranty paperwork and procedures prior to the start of the project.

C. Contractor shall provide a minimum one (1) year warranty on installation and workmanship PLUS an Extended Product Warranty and System Assurance Warranty for this wiring system and shall commit to make available local support for the product and system during the Warranty period.

1. The Extended Product Warranty shall apply to all passive structured cabling system components and shall cover the replacement or repair of defective products and labor for the replacement or repair of such defective products for a minimum of one (1) year.
2. The System Assurance Warranty provides a complete system and product warranty that will be extended to the end-user, ensuring the structured cabling system will be free of defects in materials and workmanship, will meet or exceed applicable performance requirements defined in the contract documents, and support all current and future network applications for a minimum of twenty (20) years.

D. Contractors Warranty
1. General requirements: Comply with additional requirements in contract general requirements and extended warranties required in other specification sections.
   a. Refer to all other 27xxxx sections for specific additional warranty requirements that exceed or are in addition to those of this section.
2. Contractor warranty: Provide all services, materials and equipment necessary for successful operation of entire telecommunications system and SCS system for a period of one year after system acceptance. Scope of warranty includes all equipment, devices, wiring, accessories, software, hardware, installation, programming, and configuration required to maintain a complete and operable system. Provide manufacturer's published recommended preventative maintenance procedures during warranty period. This shall apply to all items except those specifically excluded, or items wherein a longer period of service and warranty is specified or indicated. All warranties shall be effective for one year, minimum, from date Certificate of Final Acceptance is issued. Use of systems provided under this section for temporary services and facilities shall not constitute final acceptance of work nor beneficial use by Owner and shall not institute warranty period. The warranty shall cover repair or replacement of defective materials, equipment, workmanship, and installation that may be incurred during this period. Warranty work is to be done promptly and to Owner's satisfaction. In addition, warranty shall cover correction of damage caused in making necessary repairs and replacements under warranty. Additional warranty responsibilities are:
   a. Obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in Owner's designated name. Replace material and equipment that require excessive service during guarantee period as determined by Owner.
   b. Provide 2-business day service beginning on date of Substantial Completion and lasting until termination of warranty period. Service shall be at no cost to Owner. Service can be provided by the installation contractor or by a separate service organization. Choice of service organization shall be subject to Owner's approval. Submit name and a phone number that will be answered on a 24-hour basis each day of week, for duration of service.
   c. Submit copies of equipment and material warranties to Owner before final acceptance.
   d. At end of warranty period, transfer manufacturers' equipment and material warranties still in force to Owner.
   e. If warranty work problems cannot be corrected immediately to Owner's satisfaction, advise Owner in writing, describing efforts to correct situation, and provide analysis of cause for problem. If necessary, to resolve problem, provide at no cost services of manufacturer's engineering and technical staff at site in a timely manner to analyze warranty issues, and develop recommendations for correction, for review and approval by Owner.
   f. Owner's rights: This section shall not be interpreted to limit Owner's rights under applicable codes and under this Contract.
3. Pathways Material and Installation warranty: Provide all services, materials and equipment necessary to warrant the installation and performance of all pathway materials for a period

of one year after beneficial use. Scope of warranty includes all equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.

4. Grounding and Bonding Material and Installation warranty: Provide all services, materials and equipment necessary for successful operation of GBS for a period of one year after beneficial use. Scope of warranty includes all equipment,
    a. devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.
5. Firestopping Material and Installation warranty: Provide all services, materials and equipment necessary to warrant the performance of all Firestopping material for a period of one year after beneficial use, or longer if required by the local AHJ. Scope of warranty includes all equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.

E. SCS Manufacturers Extended Warranty
1. SCS Systems will be covered by a two-part certification program provided by a manufacturer and that manufacturer's certified vendor. Manufacturer shall administer a follow-on program through the Vendor to provide support and service to the purchaser. The first part is an assurance program, which provides that the certified system will support the applications for which it is designed, during the minimum 15-year warranty of the certified system.
2. The second portion of the certification is a minimum 15-year warranty provided by the manufacturer and the vendor on all products within the system (cords, telecommunications outlet/connectors, cables, cross-connects, patch panels, etc.).
3. In the event that the certified system ceases to support the certified application(s), whether at the time of cutover, during normal use or when upgrading, the manufacturer and vendor shall commit to promptly implement corrective action.
4. Documentation proving the cabling system's compliance to the End-to-End Link Performance recommendations, as listed in ANS/TIA-568-B shall be provided by the Vendor prior to the structured cabling system being installed.
5. The cabling system must conform to the current issue of industry standard ANSI/TIA -568. All performance requirements of this document must be followed. As well, workmanship and installation methods used shall be equal to or better than that found in the BICSI (Building Industry Consulting Service International) ITSIM manual.
6. Purchaser demands strict adherence to the performance specifications listed in ANSI/TIA -568 series standards.
7. Manufacturer shall maintain ISO Quality Control registration for the facilities that manufacturer the product used in this cabling system.

F. System Certification: Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate, from the manufacturer, registering the installation.

1.14 PAYMENT

A. Refer to the General Contractor contract documents and/or master specifications issued by Architect for project and cost payment details.

1.15 SUBMITTALS

A. Refer to Requirements of Division 1

B. Refer to Sections 271300 and 271500

C. The Communications Contractor shall not perform any portion of the work requiring submittal and review of shop drawings, product data, or samples until HARRIS COUNTY IT has approved
   1. the respective submittal in writing. Such work shall be in accordance with approved submittals.

D. The Design Consultant and the Owner Information Technology Department (HARRIS COUNTY IT) must both approve all product data prior to procurement for all materials referenced in Division 26, 27.

E. Other City Departments may have specific needs in addition to the specification listed within. It is the design consultant responsibility to ensure other City departments get a chance to review the Division 26 and 27 specifications referenced in this specification.

F. Pre-Installation Submittal Requirements
   1. Communications Contractor shall provide certificates for the appropriate insurance coverage as defined in contract documents.
   2. City, county, and/or state telecommunication cabling permits as required by Authority Having Jurisdiction (AHJ).
   3. Executed non-disclosure agreement.
   4. Appoint a Project Manager and provide the name and contact information.
   5. Shop Drawings
      a. Communications Contractor shall submit, for approval, floor plans that identify all device locations, cable routes and quantities, cable types, riser locations, and references to installation details and diagrams.
         1) Communication Contractor shall notify HARRIS COUNTY IT of cable routes exceeding permanent link length limit.
      b. Communications Contractor shall submit, for approval, diagrams that show room layouts, rack layouts (including elevations), riser layouts, etc.
      c. The Contractor shall make any corrections as required by the consultant team and submit revised shop drawings to the team for approval.
      d. Approval by the Consultant of such drawings or schedules shall not relieve the Contractor from responsibility for deviations from the drawings or specifications, nor shall it relieve the Contractor from responsibility for errors of any sort in shop drawings or schedules. Requests to deviate shall be submitted in writing to the Architect.
   6. Product Data Cut-sheets
      a. Communications Contractor shall submit catalogue cut-sheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be handwritten and/or highlighted to indicate exact selection.
      b. Communications Contractor shall identify applicable specification section reference for each product performance for each component specified for approval prior to purchase and installation.
   7. Warranty
      a. The Communications Contractor shall submit appropriate documentation from the certifying manufacturer showing the project is registered and qualified for the System Assurance Warranty.
      b. All subsequent work shall be in accordance with approved submittals. The Communications Contractor shall not perform any portion of the work requiring approval of the System Assurance Warranty manufacturer’s warranty registration qualification procedures that would
         1) disqualify any part or all of the wiring system from that warranty qualification.
   8. Qualifications

a. Communications Contractor shall submit a list of the Contractor's previous projects that demonstrate qualification for this project. This list shall include, but not be limited to:
    1) At least ten (10) other projects in the last five (5) years
    2) Name and location of project
    3) Project contacts, email addresses, and phone numbers
    4) Total square footage
    5) Total number of cables/drops
    6) Types of media
b. Communications Contractor shall submit an up-to-date and valid statement of qualifications for those assigned to perform the work specified herein at time of bid submission.
    1) Communications Contractor Employees
    2) Subcontractors
c. Manufacturer certifications for Contractor and installers.

9. Cable Testing Plan
    a. The Contractor shall provide a complete and detailed test plan for approval of the cabling system specified herein, including a complete list of test equipment for copper and fiber components and accessories prior to beginning cable testing.
    b. The following minimal items shall be submitted for review:
        1) A testing plan that clearly describes procedures and methods.
        2) Product data for test equipment.
        3) Certifications and qualifications of all persons conducting the testing.
        4) Calibration certificates indicating that equipment calibration meets National Institute of Standards and Technology (NIST) standards and has been calibrated at least once in the previous year of the testing date.
        5) Examples of test reports, including all graphs, tables, and charts necessary for display of testing results.
10. Samples
    a. For workstation outlet connectors, jack assemblies, housings and faceplates for color selection and evaluation of technical specifications and requirements. Confirm with Architect, interior designer, and OWNER representative for color before purchasing materials.
11. Unit Pricing
    a. Provide add/deduct unit pricing for a permanent link, including all components, with an average cable length of a linear 150'-0". All requirements and specifications will be enforced.
12. Technology Implementation Plan
    a. All major components of the communications systems shall be included in the implementation plan for review and approval.

G. Closeout Submittal Requirements
1. As-Built Drawings
    a. Communications Design drawings are to be supplied to the Architect to prepare the master "As-Built" drawings.
    b. Submit one electronic copy and one hard copy with project deliverables within three (3) weeks subsequent to substantial completion.
    c. As-Built drawings shall include one copy in AutoCAD format and one copy in PDF, same version as used by Architect and consultant. Dimensions and scale of the drawing sheets submitted shall match the size of the drawing sheets used for the contract documents.
    d. Utilize normal recognized drafting procedures that match AutoCAD standards, Architect and Consultant guidelines, and methodology.

e. The As-Built drawings shall incorporate all changes made to the building identified in, but not limited to, addendum, change notices, site instructions or deviations resulting from site conditions.
   1) Contractor shall clearly identify any resubmitted drawing sheets, documents or cut sheets either by using a color to highlight or cloud around resubmitted information.
   2) Maintain drawing numbering or page/sheet scheme consistency as per previously issued drawings/documents.
f. Provide dimensioned plan and elevation views of networking components, showing:
   1) All work area outlet locations complete with outlet/cable labeling.
   2) Rack and/or cabinet locations complete with labeling.
   3) One-line diagram of equipment/device interconnections with the cable plant.
   4) Standard or typical details of installations unique to OWNER’s requirements.
   5) Graphic symbols and component identification on detail drawing shall conform to Owner IT standards and industry best practices.

2. The Communications Contractor shall deliver the Installer's Extended Product Warranty and Manufacturer's signed System Assurance Warranty of installed cabling system to include all components that comprise the complete cabling system.
   a. Delivery shall be completed within two (2) weeks of the time of final punch list review.
   b. Product Certificates shall be signed by manufacturers of cables, connectors, and terminal equipment certifying that products furnished comply with requirements.
3. Cable Testing Report Requirements
   a. Submit certified test reports of Contractor-performed tests. Contractor shall submit the required Test Reports in the format and media specified, upon completion of testing the installed system.
   b. The tests shall clearly demonstrate that the media and its components fully comply with the requirements specified herein.
   c. Three (3) sets of electronic and hardcopy versions of test reports shall be submitted together and clearly identified with cable designations.
   d. Cable inventory data shall be submitted for all fiber, copper, and coaxial cabling and termination components. Include products furnished:
      1) Manufacturer's name
      2) Manufacturer's part numbers
      3) Cable designations
      4) Location and riser assignments
      5) Product Data

H. The Contractor’s BICSI Registered Communications Distribution Designer (RCDD) supervisor shall review, approve and stamp all documents prior to submitting. The Contractor’s RCDD shall warrant in writing that 100% of the installation meets the requirements specified herein upon completion of all work.

PART 2 - PRODUCTS

2.01 SUMMARY

A. Equipment and materials shall be standard products of a manufacturer regularly engaged in the manufacture of telecommunications cabling products and shall be the manufacturer’s latest standard design in satisfactory use for at least one year prior to bid opening.

B. All material and equipment, as provided, should be the standard Commercial-Off-The- Shelf (COTS) products of a manufacturer engaged in the manufacturing of such products.
   1. All shall be typical commercial designs that comply with the requirements specified.
   2. All material and equipment shall be readily available through manufacturers and/or distributors.

C. All equipment shall be standard catalogued items of the manufacturer and shall be supplied complete with any optional items required for proper installation.

D. Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance and backward compatibility.

E. All materials shall be UL- and/or ETL-approved and labeled in accordance with NEC for all products where labeling service normally applies.

F. Materials and equipment requiring UL 94, 149 or 1863 listing shall be so labeled. Modification of products that nullifies UL labels is not permitted.

G. Backward Compatibility: The provided products shall be backward compatible with lower category ratings such that if higher category components are used with lower category components, the basic link and channel measures shall meet or exceed the lower category's specified parameters.

H. Component Compliance: The provided products shall each meet the minimum transmission specifications listed herein such that no individual component will be less than specifications for permanent link and channel, regardless of the fact that tests for link and channel ultimately meet required specifications.

I. All hardware, software, firmware, and/or operating system requirements given are the minimum requirements. The Contractor's product shall meet or exceed these requirements. The product selected shall meet the operational, functional, and
   1. performance requirements specified herein. Additionally, due to the rapid advancement and antiquation of technology related products, the supplied product shall be the "contemporary technical equivalent" of that specified without additional cost to Owner. "Contemporary technical equivalent" shall be based on a comparison of technology at the time of publication of specification to the technology at the time of the first product submittal. Final product approval is at the sole discretion of the City.

2.02 PRODUCT SUBSTITUTION

A. Products listed as "No Substitution" or "Substitution not permitted" shall not be substituted. Substitution may only be considered when a product becomes unavailable through no fault of the Contractor.

B. For products listed as "or approved equal", substitution products from different manufacturers are allowed. Include written substitution request with product submittal for review and approval.

C. Product substitution shall not void, alter or change manufacturers' structured cabling system warranty.

D. Document substitution requests with complete data substantiating compliance of proposed substitution with Contract Documents. Include the following in each request for substitution:
   1. Product identification, manufacturer's name and address
   2. Reason for the substitution
   3. Product Data:
      a. Description, performance and test data, reference standards, finishes and colors.
      b. Samples: Finishes.
      c. Complete and accurate drawings indicating construction revisions required (if any) to accommodate substitutions.
      d. Data relating to changes required in construction schedule.
      e. Cost comparison between specified and proposed substitution.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

F. HARRIS COUNTY IT will be the final judge of acceptability, with review by IT Consultant and the distribution of the acceptance by the Architect.

G. No substitute shall be ordered, installed or utilized without written verification of acceptance from HARRIS COUNTY IT.

2.03 PROCUREMENT

A. Due to the rapid development of technology, the contractor shall ensure that all communications products are timely fashion, but not outdated by the installation date.

B. The “Procurement Lead Time” shall be expressed in days or weeks, and shall include time required for the contractor’s personnel to order and receive the material. Substantiation may be required.

C. “Installation Start Date” and “Installation Duration” should be an accurate estimate based on known facts in the project. Substantiation may be required.

D. The Contractor shall not purchase any materials requiring submittals until HARRIS COUNTY IT approves the submittal for that material and the Technology Implementation Plan.

E. The Contractor shall not purchase any materials requiring submittals until the date established by HARRIS COUNTY IT as the Purchasing Authorized Date.

PART 3 - EXECUTION

3.01 PREPARATION

A. Field Measurements
   1. Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.

B. Established Dimensions
   1. Where field measurements cannot be made without delaying the work, coordinate with the General Contractor to establish dimensions.
   2. When approved in writing, proceed with fabricating units without field measurements.
   3. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

C. Pre-installation inspection
   1. The Contractor shall visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport.
   2. Visibly damaged goods are not acceptable and shall be replaced by the contractor at no additional cost to Owner.

3.02 INSTALLATION

A. General

3.03 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2025.

B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.

C. ASTM A510/A510M - Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel; 2025.

D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.

E. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2024).

F. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2023.

G. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).

H. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

I. IEEE 142 - IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems; 2007, with Errata (2014).

J. IEEE 1100 - IEEE Recommended Practice for Powering and Grounding Electronic Equipment; 2005.

K. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.

L. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.

M. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

N. TIA-569 - Telecommunications Pathways and Spaces; 2019e, with Addendum (2022).

O. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2021d.

P. TIA-607 - Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2024e.

Q. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

R. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

S. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

T. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

U. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

V. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

W. UL 651A - High Density Polyethylene (HDPE) Conduit; Current Edition, Including All Revisions.

X. UL 1666 - Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts; Current Edition, Including All Revisions.
   1. Contractor shall install work in accordance with specifications, drawings, manufacturer’s instructions and approved submittal data.

Y. Allowable cable bend radius and pull tension:
   a. In general, communications cable cannot tolerate sharp bends or excessive pull tension during installation.
   b. Refer to cable manufacturer's bend radius recommendations for the maximum allowable limits.
   c. After installation, exposed cable and other surfaces must be cleaned free of lubricant residue. Use only lubricants specifically designed for cable installation.

Z. Pull Strings
   1. Provide pull strings in all new conduits, including all conduits with cable installed (trailer strings) as part of this contract.
   2. Data and video cables can be pulled in tandem with pull strings.
   3. The pull strings must move freely to prevent cable jacket/cable damage during pulls.

AA. Labeling
   1. Cable labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.
   2. Flat-surface labels: Self-adhesive vinyl or vinyl-cloth labels, machine printed with alphanumeric cable designations.
   3. Provide transparent plastic label holders, and 4-pair marked colored labels.

4. In accordance with ANSI/TIA-606-B "Administration Standard for Commercial Telecommunications Infrastructure":
    a. Install colored labels according to the type of field as per color code designations.
    b. Use “designation strip color-code guidelines for voice, data, cross- connect, riser, and backbone fields”.
5. Pathway Labels and Labeling System
    a. Labeling system shall consist of a hand-held portable printer
    b. Conduits: General-purpose label designed for powdered coated surfaces with an ultra-aggressive adhesive. Label size shall be appropriate for the conduit size. Font size shall be legible from the finished floor.
    c. Inner duct: Polyethylene general-purpose tagging material attached using tie wraps.
    d. Junction boxes: General-purpose label designed for powdered coated surfaces with an ultra-aggressive adhesive, trade name. Font size shall be easily visible from the finished floor.
    e. All labels shall be permanent, i.e. will not fade, peel, or deteriorate due to environment or time.
    f. Identification
        1) All conduits, junction boxes, gutters, and pull boxes shall have machine-generated labels easily visible from the finished floor.
        2) Conduits shall be labeled with the word “communications” and the conduit’s origination room number and destination room number.
        3) The Contractor shall label conduit at each wall and floor penetration and at each conduit termination, such as outlet boxes, pull boxes, and junction boxes, or as otherwise specified in other sections.
        4) Junction boxes, gutters and pull boxes shall be labeled with identification name or number as determined by contractor and submitted for approval.
        5) The Contractor shall label conduit sleeves at each wall and floor penetration.

BB. Firestop
1. Provide approved fire-resistant materials to restore originally-designed fire- ratings to all wall, floor, and ceiling penetrations used in the distribution and installation for communications cabling system.
2. Install and seal penetrations (conduit, sleeves, slots, chases) in fire-rated barriers created for communications infrastructure to prevent the passage of smoke, fire, toxic gas, or water through the penetrations.
3. The firestopping material shall maintain/establish the fire-rated integrity of the wall/barrier that has been penetrated.
4. All through penetrations in a fire rated surface require a sleeve, regardless of penetration diameter or penetrating cable count.
5. Using a “ring and string” method of installing cabling for membrane penetrations in a wall cavity is acceptable, provided the solution was accepted by HARRIS COUNTY IT in writing. Code-compliant firestopping rules still apply.
6. Coordinate firestopping procedures and materials with General Contractor.
7. Sharing the pathway of other trades/utilities through compliant and non-compliant penetrations does not remove the requirement to maintain code-compliant firestopping.
8. Provide and install removable, intumescent mechanical systems in floor chases for all openings greater than 0’-4”.
9. Provide and install removable, intumescent, firestop bricks for all openings greater than 0’-4” where there are penetrations through walls.
10. Bricks shall be listed for insertion in fire-rated openings and require restraining materials or apparatus as needed per manufacturers’ specifications.
11. Provide manufacturer recommended material for rated protection for any given barrier.
12. Laminate and permanently affix adjacent to chases the following information:

a. Manufacturer of firestop system.
b. Date of installation/repair.
c. Part and model numbers of system and all components.
d. Name and phone numbers of local distributor and manufacturer's corporate headquarters.

13. Solutions and shop drawings/submittals for firestop materials and systems shall be presented to the General Contractor for written approval of materials/systems prior to purchase and installation.
14. Materials shall be installed per manufacturer instructions, be UL-listed for intended use, and meet NEC and locals codes for fire stopping measures.
15. The material chosen shall be distinctively colored to be clearly distinguishable from other materials, adhere to itself, and maintain the characteristics for which it is designed to allow for the removal and/or addition of communication cables without the necessity of drilling holes in the material.
16. Develop training manuals with instructions on methods of adding or removing cabling to/from firestopped sleeves and chases.

CC. Within the normal environment, the installed systems shall not generate nor be susceptible to any harmful electromagnetic emission, radiation, or induction that degrades, or obstructs any equipment.

DD. Expansion Capability: Unless otherwise indicated, provide spare conductor pairs in cables, positions in patch panels, cross connects, and terminal strips, and space in cable pathways and backboard layouts to accommodate 20% future increase in structure cable system capacity.

EE. In the event of a breach of the representations and warranties contained herein, the Contractor, at their own expense, shall take all measures necessary to make the cabling system work and comply with the applicable manufacturer written technical recommendations and standards.

FF. System Tests
1. Upon completion of the installation of the communications infrastructure systems, including all pathways and grounding, the Contractor shall test the system.
   a. Cables and termination modules shall be affixed, mounted or installed to the designed/specified permanent location prior to testing.
   b. Any removal and reinstallation of any component in a circuit, including faceplates, shall require retesting of that circuit and any other disturbed or affected circuits.
   c. Approved instruments, apparatus, services, and qualified personnel shall be utilized.
   d. The Contractor must verify that the requirements of the specifications are fully met through testing with an approved tester (rated for testing parameters listed elsewhere), and documentation as specified below.
   e. This includes confirmation of requirements by demonstration, testing and inspection. Demonstration shall be provided at final walk-through in soft copy and printed test data.
2. Non-Compliant Cabling
   a. Testing that shows some or all pairs of a cable do not comply with specifications, without written approval by HARRIS COUNTY IT, shall be replaced at Contractor's expense (including respective connectors).
   b. With HARRIS COUNTY IT's written approval, the over-length cable(s) shall be excluded from requirements to pass standardized tests and shall be explicitly identified.
      1) Testing is still required for non-compliant cabling.
      2) The tests shall be for wire-mapping, opens, cable-pair shorts, and shorts-to-ground.
      3) The test results must be within acceptable tolerances and shall be submitted with HARRIS COUNTY IT's acceptance document.
3. Failed Tests

a. If tests fail, Contractor shall correct as required to produce a legitimate passing test.
b. Manipulation of tester parameters on a failing test in order to achieve a passing test is unacceptable.
c. If the Contractor is found to have manipulated or falsified any failing test result to show a “PASS” for any reason (without written notice and prior approval of HARRIS COUNTY IT), the Contractor shall be required to employ a Third- Party Testing Agent selected by HARRIS COUNTY IT to retest the complete cable plant and shall be required to pay all costs associated with this retesting.

4. HARRIS COUNTY IT reserves the right to be present during any or all testing.

3.04 CLEANING

A. The Contractor will clean all surfaces prior to final acceptance by HARRIS COUNTY IT.

3.05 COMPLETION INSPECTION AND PUNCH LIST

A. Before scheduling the completion inspection, the contractor’s supervisor (RCDD) shall walk the site to verify that all scope of work has been completed per the construction
   1. documents and the City’s IT standards, and all required documentation (as-built drawings, test reports, etc.) have been submitted.

B. Provide the Engineer and HARRIS COUNTY IT with a minimum one-week notice prior to scheduling the final completion inspection. Submit a completed Request for Communications Completion Inspection to the HARRIS COUNTY IT representative and Engineer.

C. A Punch List will be generated during the Completion Inspection to document all deficiencies in need of corrective action.

D. Complete all punch list deficiencies within 10 working days. The work is not complete until all punch list deficiencies have been addressed.

3.06 ACCEPTANCE AND CLOSEOUT

A. Contractor must warrant in writing that 100% of the installation meets the requirements specified herein (Standards Compliance & Test Requirements).

B. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation soft and hard copies as described herein.

C. Once all work has been completed, closeout documentation has been submitted, and HARRIS COUNTY IT is satisfied that all work is in accordance with contract documents, HARRIS COUNTY IT shall notify Contractor in writing of formal acceptance of the system.

END OF SECTION

SECTION 270526
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

GENERAL

1.01 SUMMARY

A. This Section specifies the requirements for the Communications Grounding and Bonding.

1.02 RELATED SECTIONS:

A. Div 01

B. Section 270000 Communications

C. Section 270528 Interior Pathways for Communications Systems

D. Section 270543 Exterior Pathway for Communications Systems

E. Section 270553 Identification for Communications Systems

F. Section 271100 Communications Equipment Room Fittings

G. Section 271300 Communications Backbone Cabling

H. Section 271500 Communications Horizontal Cabling

I. Section 272100 Data Communication Network Equipment

1.03 REFERENCES

A. Refer to section 270000

1.04 DEFINITIONS AND ABBREVIATIONS

A. Section 270000

B. PBB – Primary Bonding Busbar for Communications systems: The dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The central attachment point for the TBB's and equipment typically located in the MDF, also known as the Main Cross-connect (MC).

C. SBB – Secondary Bonding Busbar: The grounding connection point for telecommunications systems and equipment in the area typically served by a Telecommunications Room other than the MDF.

D. TBB - Telecommunications Bonding Backbone: A bonding conductor that interconnects the PBB to the SBBs.

E. TBC – Telecommunications Bonding Conductor that bonds the PBB to the electrical power ground.

F. BBC – Backbone Bonding Conductor : A conductor that interconnects Telecommunications Bonding Backbone.

G. Exothermic Weld: A method of permanently bonding two metals together by controlled heat reaction resulting in a molecular bond.

1.05 SYSTEM DESCRIPTION

A. General

1. All conductor wire, busbars and conduit shall be UL listed.
2. The communications grounding/bonding system shall be independent from all power grounding except for the connection to the building’s electrical service main grounding electrode system.
3. Power grounding and/or bonding shall not be allowed to interfere or provide any back feed or be a conductor to the separate communications ground system source or to any communications bonded materials or equipment.

1.06 PBB AND TBC

A. The main ground source feed for the PBB located in the MC (MDF) shall be an independ- ent feed from the building's electrical service main grounding electrode system, known as the Telecommunications Bonding Conductor (TBC).

B. The TBC shall be a stranded copper ground wire from the building ground system to the PBB in the MC (MDF) sized at a minimum #4/0 unless otherwise sized by the Electrical Engineer of Record.

C. The TBC connections shall be low emission exothermic welds at the connecting ends.

1.07 TELECOMMUNICATION BONDING BACKBONE (TBB) AND SBB

A. The Telecommunication Bonding Backbone (TBB) originates at the PBB and shall be extended from the PBB within the MC (MDF) throughout the building along the same route as the telecommunications backbone pathways, to the SBB in each TR (IDF).

B. The minimum TBB conductor size between busbars shall be a stranded copper ground wire one (1) AWG size smaller than the TBC.

1.08 BACKBONE BONDING CONDUCTOR (BBC)

A. Whenever two or more TBBs are used in a multistory building, the TBBs shall be bonded together with a BBC (by low emission exothermic welds) at the top floor and at a minimum of every third floor in between with a copper conductor equal to the gauge of the TBB.

1.09 TEBC AND RBC

A. All cabinets and racks shall be connected by the Telecommunications Equipment Bond- ing Conductor (TEBC). The TEBC is a stranded copper #4 conductor from the PBB/SBB extending along each row of racks within the room. Bond each rack with a Rack Bonding Conductor (RBC). The RBC is a stranded copper #6 conductor connected to the vertical rack bonding terminal. All connections shall be irreversible crimp connections. Route conductor so as to minimize the quantity of sweeping bends.

1.10 SUBMITTALS

A. Refer to sections 270000

1.11 DELIVERY, STORAGE, AND HANDLING

A. Refer to sections 270000

1.12 PROJECT/SITE CONDITIONS

A. Refer to section 270000

1.13 WARRANTY

A. Refer to section 270000

1.14 MAINTENANCE AND SUPPORT

A. Refer to section 270000

PART 2 PRODUCTS

2.01 TELECOMMUNICATIONS BUSBARS

A. Material: Copper, 1/4" thick (aluminum not permitted).

B. Pre-drilled
   1. Hole spacing per ANSI Joint Standard J-STD-607 (latest revision).
   2. Hole pattern shall accommodate two-hole lugs.

C. Busbars shall be listed by a nationally recognized testing laboratory.

2.02 PRIMARY BONDING BUSBAR (PBB)

A. Panduit #GB4B0624TPI-1 ground busbar with busbar insulators, standoff brackets, stainless steel bolts with Torx T-45 head, 20”x4” minimum.

2.03 SECONDARY BONDING BUSBAR (SBB)

A. Panduit #GB4B0612TPI-1 ground busbar with busbar insulators, standoff brackets, stainless steel bolts with Torx T-45 head, 12”x4” minimum.

2.04 GROUNDING JOINTS/SPLICES

A. Grounding conductor joints/splices shall be mechanical type, copper alloy, with a minimum of two bolts and a separate section for each conductor equal to Burndy “QPX”, OZ/Gedney “XTP” or “PMX” or Penn-Union “VX” or copper compression type with two (2) indents equal to Burndy, T&B or Blackburn.

B. Grounding conductor terminations (lugs) shall be single barrel, mechanical screw type, copper alloy with machined contact surfaces equal to OZ type “SL”, T&B, or Burndy or copper compression type with two (2) indents equal to Burndy, T&B or Blackburn.

2.05 BONDING CONDUCTORS

A. Material: Stranded copper (aluminum not permitted).

B. Equipment Frame Bonding Conductor; Panduit #TRGK672 Telecommunications Rack Grounding Kit.

C. Bonding Conductor (BC): Green insulated copper bonding conductor, size as required by NEC.

2.06 THE BC SHALL BE, AS A MINIMUM, THE SAME SIZE AS THE TBB.

A. Telecommunications Bonding Backbone (TBB): Green insulated copper conductor, minimum size of No. 6 AWG.

B. The TBB shall be sized as indicated on drawings. Where not indicated size at 2 kcmil per linear foot of conductor length up to a maximum size of 3/0 AWG. Insulation shall meet fire ratings of its pathway.

Table 1	
Sizing of the TBB	
TBB length (ft)	TBB Size (AWG)
Less than 13	6
14-20	4

2.07 EXOTHERMIC CONNECTOR MANUFACTURERS:

A. Erico Products (Cadweld)

B. Burndy Corporation (Therm-O-Weld)

C. OZ Gedney
   1. Owner approved equal

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

B. Provide the required elements and associated hardware necessary to provide a complete Telecommunications Grounding Infrastructure as specified.

3.02 PBB

A. Locate the PBB at 7’ AFF fastened to the plywood backboard near the outside plant en- trance conduits in the “MDF”.

B. TMGB shall be installed so that the BC for telecommunications is as short and straight as possible.

C. Conductor shall be installed in continuous 1 conduit.

3.03 SBB

A. Locate the SBB at 7’ AFF fastened to the plywood backboard near the copper riser termination in each “IDF”.

B. SBB shall be installed so that the TBB for telecommunications is as short and straight as possible.

3.04 TBB

A. Install non insulated copper grounding conductor in 1” conduit from PBB to each SBB.

3.05 BONDING CONDUCTOR JOINTS/SPLICES

A. Install mechanical type, copper alloy, with a minimum of two bolts and a separate section for each conductor or copper compression type with two (2) indents.

B. Install manufactured insulating cover or heavy tape insulation over joints/splices.

3.06 EQUIPMENT CABINETS AND RACKS

A. The busbar shall be installed at the base and back of each cabinet/rack for floor fed cabinets/racks.

B. The busbar shall be installed at the top and back of each cabinet/rack for top fed cabinets/racks.

C. Each cabinet and rack shall be provided with a minimum # 6 AWG ground wire.

D. Do not loop from cabinet/rack to cabinet/rack.

E. Each cabinet or rack bay against the wall shall be bottom/side ground fed from the wall.
   1. Wall ground feeds/raceways to racks shall not be exposed on the walls.
   2. Exception: Some cabinet or rack bays will require the ground to be fed from the ceiling raceway.

F. All ground raceways within each cabinet/rack or cabinet base and adjacent-ganged cab- inet base shall be an insulated metallic flex type raceway and shall not interfere with equipment mounting frames or equipment mounting brackets.

3.07 CABLE RUNWAY, CABLE RACEWAY AND SUPPORT SYSTEM GROUNDING

A. The Contractor shall provide communications cable tray and cable runway systems with a communications dedicated ground from the PBB/SBB.

B. All cable tray needs to be electrically continuous per NEC 250.96.
   1. Metal raceways, wire-mesh cable trays, cable armor, cable sheath, enclosures, frames, fittings, and other metal non-current-carrying parts that are to serve as an alternate grounding path, with or without the use of supplementary equipment grounding conductors, shall be effectively bonded where necessary to ensure elec- trical continuity and the capacity to conduct safely any fault current plausibly to be imposed on them.
   2. Any nonconductive paint, enamel, or similar coating shall be removed at the threads, contact points, and contact surfaces.
   3. Grounding or bonding conductors shall be connected by fittings designed for that purpose to ensure adequate bonding.

C. The Contractor shall provide and install a #6 AWG ground wire to bond one end of each cable tray/runway system to the PBB/SBB.

D. For electrically non-continuous conduits that contain only grounding conductor, the Con- tractor shall bond the conduit and conductor together at both ends to ground to the near- est PBB/SBB with grounding bushings or ground clamps.

3.08 SHIELDED BACKBONE CABLING

A. The Contractor shall terminate and bond the shield to the nearest PBB or SBB at both ends, following manufacturer's guidelines.

3.09 GROUNDING OF EQUIPMENT FRAME

A. Install manufactured insulating cover or heavy tape insulation over joints/splices.

B. Bonding connections should be made by using:
   1. Double crimp connectors only for all horizontal runs (cabinets trays etc.). Use listed hardware that has been laboratory tested. For double crimp connectors use 2-hole type connector.
   2. Exothermic welding (per NEC) within the ground electrode system, for parts of a grounding system that are subject to corrosion or that must carry high currents reli- ably, or for locations that require minimum maintenance. Exothermic weld to be used on the Telecommunications Bonding Backbone (TBB) conductor for all connections.

3.10 QUALITY CONTROL

A. Inspect grounding and bonding system connections and conductors for proper installation and tightness.

3.11 LABELING

A. All grounding and bonding components shall be labeled with unique printed IDs.

B. Refer to section 270553

3.12 CLEANING

A. Refer to section 270000

3.13 ACCEPTANCE

A. Refer to Section 270000.

END OF SECTION

SECTION 270528
INTERIOR PATHWAYS FOR COMMUNICATIONS SYSTEMS

GENERAL

1.01 SECTIONS INCLUDE

A. This section includes specifications for the installation of interior communications pathways.

B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division - 1 Specification Sections, apply to the work of this Section.

C. Interior Communication Pathways are defined to include, but are not limited to inner duct, conduit, pull boxes, cable hooks, cable trays, supports, accessories, associated hardware and fire stopping materials.

1.02 REFERENCES

A. Section 270000 inch (6858000 mm) its entirety shall be included as part of this specification.

1.03 RELATED SECTIONS:

A. Div 01

B. Section 270526 Grounding and Bonding for Communications Systems

C. Section 270543 Exterior Pathway for Communications Systems

D. Section 270553 Identification for Communications Systems

E. Section 271100 Communications Equipment Room Fittings

F. Section 271300 Communications Backbone Cabling

G. Section 271500 Communications Horizontal Cabling

H. Section 272100 Data Communication Network Equipment

I. Section 274116 Integrated Audio-Video Systems and Equipment

J. Section 274133 Master Antenna Television Systems

K. Section 275113 Paging System

L. Section 275319 Emergency Responder Radio Communications System

1.04 CONFLICTS:

A. Between referenced requirements: Comply with the one establishing the more stringent requirements.

B. Between reference requirements and contract documents: Comply with the one estab- lishing the more stringent requirements.

1.05 QUALITY ASSURANCE

A. Verify conduit, raceway, cable tray, and cable hook runs do not interfere with existing or new systems within each facility.

B. Fire stopping: Manufacturer trained and approved installer to perform fire stopping work who has specialized in the installation of work similar to that required for this project.

C. Communication Pathway minimum Clearances:
   1. Motors or transformers: 4 feet (121.92 cm)
   2. Power cables and conduits: 12 inches (304.8 mm) parallel, 3 inches (76.2 mm) crossover
   3. Fluorescent lights: 5 inches (127 mm)
   4. Above ceiling tiles: 3 inches (76.2 mm)
   5. Access above cable tray: 12 inches (304.8 mm)
   6. Hot Flues, Steam pipes, Hot water pipes and other hot surfaces: at least 6”

D. Furnish products of latest proven design, new and in current production. Do not use obsolete components or out-of-production products.

E. Assure that the "as installed" system is correctly and completely documented including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.

F. All installed materials and accessories shall be new from the manufacturer. No used components will be accepted by the OWNER.

G. All Documentation submittals shall be reviewed by the supervising RCDD and stamped prior to submittal.

1.06 CONTRACTOR QUALIFICATIONS:

A. The Contractor shall submit references and other related evidence of installation experi- ence for a period of three years prior to the issue date of this Specification.

B. ALL work shall be supervised on-site by a BICSI RCDD. Must demonstrate knowledge and compliance with all BICSI, ANSI/TIA, UL, and NEC standards and codes. Contractor shall submit proof of RCDD designation.

C. OWNER retains the right to have access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at NO cost to OWNER.

PART 2 PRODUCTS

2.01 GENERAL

2.02 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2025.

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.

E. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2026.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. NFPA 70B - Recommended Practice for Electrical Equipment Maintenance; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

I. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

J. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

K. UL 2024 - Standard for Cable Routing Assemblies and Communications Raceways; Current Edition, Including All Revisions.

L. Where conduit, pull boxes, cable tray and other raceway sizes are not specifically shown on contract drawings. All communication pathways shall be sized in accordance with the requirements of BICSI and the NEC.

M. All raceways, if used, shall be metal conduit. Raceways installed in stud walls or above suspended hard ceilings shall be Electrical Metallic Tubing.

2.03 INTERIOR COMMUNICATIONS CONDUIT

A. MANUFACTURES:

1. Allied
2. Triangle
3. Wheatland
4. OWNER approved equal

B. Rigid Steel Conduit shall pass all bending, ductility, and thickness of zinc coating in ANSI C80.1 and UL 6. Conduit shall be galvanized have threaded end with 1” minimum size and 4” maximum size. Fittings shall be cast iron or alloy steel, threaded and galvanized.

C. Intermediate Metal Conduit (IMC) shall be manufactured in accordance with UL 1242. Conduit shall be low carbon, hot-dipped galvanized inside and out, with threaded ends, 1” minimum size, and 4-inch maximum size. Fittings shall be cast iron or alloy steel, threaded and galvanized.

D. Electrical Metallic Tubing (EMT) shall be manufactured in accordance with UL 797 and ANSI C80.3. EMT shall be high-strength, zinc-coated, 1-inch minimum size. EMT may be used for sizes greater than 2" where physically protected. EMT shall not be utilized for service entrance conductors. Fittings shall be of same finish and material as tubing. Fittings shall be compression type with insulated throat.

E. Expansion Joint Fittings: OZ type AX or Appleton type XJB, watertight, permitting two-way movement up to 4 inches (101.6 mm), equipped with bonding jumpers around or through each fitting.

F. Thruwall Sealing Fittings: Type WSK by O-Z Gedney Company.

G. Fire-Seal Fittings: Type CFSI by O-Z Gedney Company.

H. Sealing Material for Sealing Fittings: Chico X Fiberdam, and Chico A sealing compound, or Chico A-P interpak by Crouse-Hinds or Apelco sealing cement and fiber filler by Appleton.

I. Insulated Bushings: Type B or SBT, as applicable, by O-Z Gedney or series B1900, series BU500 or series TC700, as applicable, by Steel City.

J. Provide a measured pull tape in each empty conduit, empty innerduct for backbone and riser pathways.

K. Provide a pull string for all horizontal conduits with a minimum pulling tension of 200 pounds.

L. Thread lubricant/sealant shall be Crouse-Hinds type STL or T & B Kopr-Shield except, when required on joints for heat producing elements such as lighting fixtures; it shall be Crouse-Hinds type HTL.

M. PVC Conduit shall not be used as interior communication pathways. Except when encased in concrete.

2.04 INNERDUCT

A. Manufacturers:
1. Carlon CF4X1C
2. Maxcell Premise
3. Or OWNER approved equivalent

B. All fiber cables not placed in conduits shall be installed in corrugated innerduct (Carlon or equal).

C. Fabric Innerducts (Maxcell, or equal) shall be provided in all conduits dedicated for communications backbone cabling.

D. Innerduct shall be UL Listed with Flame Propagation compliant with UL 2024.

E. Only manufacturer’s fittings, transition adapters, terminators, and fixed bends shall be used.

F. All empty innerducts will be populated with a measured pull tape.

G. Where more than one innerduct is routed in a conduit, each innerduct shall consist of a different color from end to end (ex. Orange, Blue, Black, and White). Do not couple in- nerducts of different colors without OWNER approval.

H. All interior innerduct shall be plenum rated, unless installed in conduit.

2.05 CABLE TRAYS

A. Manufacturers:
   1. Cablofil CF105/300EZ (12”W x4”H)
   2. Or approved equal

2.06 CABLE TRAY

A. Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

B. Materials and Finish: Material and finish specifications for each tray type are as follows:
   1. Aluminum: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
   2. Pre-galvanized Steel: Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties in accordance with ASTM A653 SS.
   3. Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All covers and splice plates must also be hot-dip galvanized after fabrication; mill galvanized covers are not acceptable for hot-dipped galvanized cable tray.
   4. Stainless Steel: Straight section and fitting side rails and rungs shall be made of AISI Type 304 or Type 316 stainless steel. Transverse members (rungs) or corrugated bottoms shall be welded to the side rails with Type 316 stainless steel welding wire.

2.07 TYPE OF TRAY SYSTEMS

A. All work area trays shall be basket type, UON.

B. Refer to section 271100 for ladder type trays used in Communications Rooms (MDF/IDF).

C. All tray sizes and types shall have a minimum of 2 inch (50.8 mm) usable load depth.

D. All straight sections shall be supplied in standard 10 foot (304.8 cm) length, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.

E. Tray widths shall be 12, 18, 24, or 36 inches (914.4 mm) as indicated on the drawings.

F. All fittings must have a minimum radius of 12, 24, 36 or 48 inches (1219.2 mm) as indicated on the drawings.

G. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed
   1. .00033 ohms. Splice plate construction shall be such that a splice may be located any- where within the support span without diminishing rated loading capacity of the cable tray.

H. Aluminum Tray - Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in ac- cordance with ASTM B633, SC1.

I. Steel (including Pre-galvanized and Hot-dip galvanized) - Splice plates shall be manu- factured of high strength steel, meeting the minimum mechanical properties of ASTM A1011 HSLAS, Grade 50, Class 1. Hardware shall be zinc plated in accordance with ASTM B633 SC1 for pre-

galvanized cable trays, or Chromium Zinc in accordance with ASTM F-1136-88 for hot-dip galvanized cable trays.

J. Cable Tray Support shall be placed so that the support spans do not exceed maximum span indicated on drawings or by the manufacturer. Supports shall be Trapeze style support. Cable trays installed adjacent to walls shall be supported on wall mounted brackets as specified by the manufacturer.

K. Trapeze hangers shall be supported by 3/8 inch (9.52 mm) diameter all thread rods. No center hung method is allowed.

L. Accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but are not limited to; section splice plates, expan- sion plates, blind-end plates, specially designed ladder dropouts, barriers, etc.

M. All cable tray components and accessories will be from the same manufacturer. Parts from different manufacturer will not be intermixed.

2.08 CABLE HOOK SYSTEMS

A. Manufacturers:
   1. Nvent CAT32HP4Z34
   2. Or approved equal

B. Cable hooks shall have a flat bottom and provide a minimum of 1-5/8 inch (41 mm) cable bearing sur- face.

C. Cable hooks shall have 90-degree radiused edges to prevent damage while installing cables.

D. Cable hooks shall be designed so the mounting hardware is recessed to prevent cable damage.

E. Cable hooks shall have a cable latch retainer to provide containment of cables within the hook. The retainer shall be removable and reusable.

F. Cable hooks shall be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions.

G. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3.

H. Cable hooks for corrosive areas shall be stainless steel, AISI Type 304.

I. All Cable Hook shall be supported with minimum ¼” all thread with the appropriate fasteners.

2.09 FIRESTOPPING MATERIALS

A. Manufacturers:
   1. Johns Manyille
   2. Hilti
   3. 3M

B. Description:
   1. Performance requirements: Provide firestopping systems that are produced and installed to resist spread of fire according to requirement indicated, resist passage of smoke and other gases, and maintain fire resistance rating of assembly.
      a. F- Rated Systems: in accordance with ASTM E814
      b. T- Rated Systems: in accordance with ASTM E814
   2. Fire stopping flame spread performance requirements: Provide products with flame-spread ratings of less than 25 and smoke development ratings of less than 50 as deter-mined in accordance with ASTM E84.
   3. Fire Stopping UL performance requirements: Provide products with UL ratings specified for assembly indicated as determined in accordance with UL listings.

2.10 JUNCTION BOXES/PULL BOXES

A. All pull boxes shall be constructed with a minimum of 14-gauge galvanized steel with an ANSI 61 grey polyester powder finish inside and out over phosphatized surfaces or galvanizes steel unless otherwise specified.

B. All pull boxes shall have flat, removable covers fastened with plated steel screws with unique keyhole screw slots in the cover to permit removal of the cover without extracting screws unless otherwise specified.

C. All removable box covers shall be connected to box with a safety strap or chain.

D. All pull boxes shall provide the appropriate provisioning for grounding.

E. All pull boxes shall be NEMA Type 1 and sized according to the table below unless otherwise specified.

Maximum Trade Size of Conduit (inches)	Minimum Box Size (inches)			For Each Additional Conduit Increase Width (Inches)
	Width	Length	Depth 3	
1	4	16		2
1.25	6	20	3	3
1.5	8	27	4	4
2	8	36	4	5
2.5	10	42	5	6
3	12	48	5	6
3.5	12	54	6	6
4	15	60	8	8

2.11 CONDUIT PULL LINE

A. Description
1. Minimum pulling tension greater than 200 lb (900 N).
2. Ready-to-use cable pull line,
3. Use directly from the container.
4. Resists tangling when dispensing.
5. Rot and mildew resistant.
6. Handy reusable plastic dispenser pail with handle keeps the line dry.
7. Greenlee 430 or approved equivalent.

PART 3 EXECUTION

3.01 GENERAL

A. Raceways shall be mechanically and electrically connected to all boxes and fittings and shall be properly grounded per NEC.

B. The routing and location of all conduits, cable tray, cable hooks and other raceways shall be coordinated with other trades prior to and during building construction to avoid delays and conflicts.

C. Where raceways pass through walls, partitions and floors, seal penetrations to provide a neat installation that will maintain the integrity of the waterproofing or fireproofing, as applicable, of the structure. Coordinate installation requirements with roofing installer where conduits pass through the roof.

D. All Raceways shall be run at least 6-inches from hot flues, steam pipes, hot water pipes and other hot surfaces.

E. All raceways entering a building from underground shall be sealed to prevent water, moisture, gas, or any other foreign matter from entering the building. Service conduits shall be sealed in accordance with NEC 230-8.

F. Contractor's on-site RCDD supervisor shall review, approve and stamp all shop drawings, coordination drawings and records drawings.

G. Do NOT route communication pathways under HVAC condensing units.

H. Expansion Fittings:
   1. Raceways shall be provided with expansion fitting where necessary to compensate for thermal expansion and contraction.
   2. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit funs where necessary. Provide bonding jumpers across fittings in metal raceways systems

3.02 CONDUIT INSTALLATION

A. Conduit shall be installed with threaded fittings and couplings.

B. All metallic couplings, connectors and fittings shall be malleable iron or steel and finished with zinc plating or by galvanizing.

C. All conduits shall be plugged immediately upon installation to prevent the entrance of construction dirt and debris. All conduits shall be swabbed and cleaned before wires are pulled.

D. All open conduits must be provided with a pull rope with a minimum pull tension of 200+ pounds.

E. Expansion fittings shall be utilized in all cases where conduits pass through building expansion joints. Fittings shall be of an approved weatherproof telescopic type permitting a movement of up to four inches and shall be provided with approved bonding jumpers around or through the fitting.

3.03 CONNECTION OF CONDUIT TO PULL / JUNCTION BOXES AND ENCLOSURES:

A. Connection to NEMA 1 type boxes and enclosures:
   1. Rigid conduit: Install insulated bushings and double locknuts.
   2. EMT: Install compression box connectors with insulated throats.

B. Connection to NEMA 3R, 4, 4X, and 12 type boxes: Install insulated bushings and seal- ing locknuts or hubs.

C. When conduits enter floor-mounted enclosures from below and there is no sheet metal to which to attach; install grounding bushings on the conduit. Bond bushings to ground bus using a conductor the same size as required for an equipment grounding conductor sized for the given circuit.

D. Install sealing bushing within all conduits that have entered a building from outside, whether from above or below grade.

E. Each Conduit route shall be installed with the least amount bends as possible. No section of conduit shall be longer than 30m (100 ft) or contain more than two 90 degrees bends (offset is considered to be a 90 degree bend) between pull points, pull boxes or reverse bends.

F. The inside radius of bends in conduit shall be:
   1. 6 times the internal diameter for 2-inches or less.
   2. 10 times the internal diameter for greater than 2-inches.

G. A measured pull tape shall be placed in all installed conduit.

H. All communications conduits shall be identified with color coded orange tape marked “Communications” every 50 feet (1524 cm). Tag conduit termination points (to include J-box locations) with the origination and destination location.

I. Conduit shall be reamed to eliminate sharp edges and terminated with an insulated bushing.

J. Conduit protruding through the floor shall be terminated at a minimum of 3 inches (76.2 mm) above the floor surface.

K. All stubbed conduit ends shall be provided with a ground bushing.

L. All conduit penetrations shall be provided with the proper conduit sleeves.

M. Sleeves shall extend three inches AFF or four inches below finished ceiling, with a bush- ing.

N. Sleeves shall be installed in the communications room floor or ceiling a minimum of two to four inches on center from the wall.

O. Conduit floor sleeves shall be spaced to allow space for ground bushing and insulated bushing for cable protection.

P. Shall be installed in a single tier or row from left to right horizontally. If two tiers or rows are required the conduits shall be staggered minimum of 2 inches (50.8 mm) between tiers.

Q. Cable support anchors shall be installed 18 to 24 inches (609.6 mm) above the sleeves.

R. All cable (horizontal, riser or backbone) wall or ceiling penetrations shall be provided with the proper conduit sleeves.

S. Sleeves shall extend three inches AFF or four inches below finished ceiling, with a bush- ing.

T. Sleeves shall be installed in the floor or ceiling a minimum of two to four inches on center from the wall.

U. Sleeves shall be installed in the walls at a minimum of two inches extended on each side of the wall.

V. Cable floor, ceiling and wall sleeves shall be spaced to allow space for ground bushing and insulated bushing for cable protection.

W. Shall be installed in a single tier or row from left to right horizontally.

X. If two tiers or rows are required the conduits shall be staggered minimum of 2 inches (50.8 mm) between tiers.

Y. Cable support anchors shall be installed 18 to 24 inches (609.6 mm) above the sleeves.

Z. All conduit and cabinet entrances shall be sealed with an approved, re-enter able sealant material to prevent ingress of water, dust or other foreign materials.

AA. Install all exposed conduit parallel or perpendicular to lines of existing construction and grouped together where possible, without interfering with use of premises or working areas. Prevent safety hazards and interference with operating and maintenance procedures.

3.04 CONDUIT SIZING AND SUPPORTS:

A. Support conduit 2 inches (50.8 mm) and larger at 10 feet (304.8 cm) on center maximum, and conduit 1½ inch and smaller at eight feet on center maximum.

B. Fasten 1½ inch and smaller conduit to concrete, masonry or steel with either one-hole malleable iron conduit straps, or "Korn" clamps, or U-bolts; for larger diameters, use two- hole straps. Use "clamp backs" for strapping conduits to planar surfaces.

C. Multiple runs shall be supported on channel adequately secured to walls or hung from structure above with conduits fastened to channel with clamps designed for the purpose.

D. Cable fill rates shall not exceed 40 percent of the cross-sectional area of the installed conduit unless greater fill is approved by Engineer. Contractor shall submit request for approval for

installing cables with greater than 40 percent conduit fill. Request will be approved on a case-by-case basis.

3.05 HORIZONTAL CONDUIT ROUTES:

A. Horizontal (station) conduit is defined as the conduit run between the communications outlet and the cable tray or communications room as indicated on Drawings.

B. Each horizontal conduit run shall be a one-inch metallic conduit and shall be home run from each communications outlet box to the equipment room, terminating equipment or cable tray, as indicated in Drawings.

C. Each route shall be installed with the least amount of conduit bends. Each single hori- zontal conduit run shall be provided with a junction or pull box every 30m (100 ft) or contain more than two 90 degrees bends (offset is considered to be a 90 degree bend).

D. Each dual horizontal conduit run shall be provided with a junction or pull box every 30m (100 ft) or contain more than two 90 degrees bends (offset is considered to be a 90 de- gree bend). The quantity of conduits entering the junction or pull box shall equal the number of conduits exiting the junction or pull box.

E. Each terminating (outlet end) conduit connection shall be provided with the proper con- necting insulated bushing or fitting.

F. Each originating end (communications room end) shall be provided with the proper con- necting insulated ground bushing and properly bonded to ground.

3.06 HORIZONTAL CONDUIT ENTRANCE IN COMMUNICATIONS ROOMS – WALL ENTRY

A. Horizontal conduits shall enter the communications room wall 12 to 18 inches (457.2 mm) above the top of the cable tray. Maintain cable bend radius with supporting device as required.

B. Conduit wall stubs shall be spaced in increments equal to the conduit outside diameter (OD) from each other.

C. All conduit wall stubs shall be extended to the terminating equipment, electronics, or ca- ble tray, as noted in Drawings.

D. Conduit crossovers are not permitted.

3.07 HORIZONTAL CONDUIT ENTRANCE IN COMMUNICATIONS ROOMS – CEILING ENTRY

A. Horizontal conduits shall enter or be extended from the equipment room ceiling 12 to 18 inches (457.2 mm) above the top of the cable tray.

B. Ceiling conduit stubs shall be spaced in increments equal to the conduit OD from each other.

C. All ceiling conduit stubs shall be extended to the terminating equipment, electronics, or cable tray, as noted in Drawings.

D. Conduit crossovers are not permitted.

3.08 HORIZONTAL CONDUIT ENTRANCE IN COMMUNICATIONS ROOMS – FLOOR ENTRY

A. Horizontal conduits shall enter the communications room floor two inches to four inches on center from the wall and shall be stubbed 4 inches (101.6 mm) AFF.

B. Conduit floor stubs shall be spaced in increments equal to the conduit OD from each other.

C. Conduit crossovers are not permitted.

D. Provide vertical ladder rack or d-hooks properly secured to wall to transverse cable to cable tray over-head.

3.09 HORIZONTAL CONDUIT TO CABLE TRAY

A. Non-communications conduit shall NOT be attached to the cable tray in any fashion.

B. Conduit terminating end shall be attached to cable tray side rail with “conduit-to-cable tray” clamps. No other form of attachment shall be permitted.

C. Top or bottom cable tray conduit feeds and attachments are not permitted.

3.10 HORIZONTAL JUNCTION/OUTLET BOXES

A. Each horizontal conduit shall be terminated into an outlet box.

B. Each outlet box shall be a deep four-inch square junction box with a minimum of two one- inch knockouts on each of the sides.

3.11 RISER CONDUIT ENTRANCE IN COMMUNICATIONS ROOMS – WALL ENTRY

A. Riser conduits shall enter the communications room wall a minimum of 24 inches (609.6 mm) above the top of the cable tray.

B. Conduit wall stubs shall be spaced in increments to equal the conduit OD from each other.

C. Riser conduits shall be installed in a single tier or row from left to right horizontally.
   1. If two tiers or rows are required, the conduits shall be staggered between tiers.
   2. No more than two tiers or rows are permitted.

D. All conduit wall stubs shall be extended to and over the cable tray to access cable tray pathway.

E. All riser conduit stubs shall be provided with the proper universal drop-out/ waterfall cable exit runway, which shall be supported by and mounted to channel strut.

F. Conduit crossovers are not permitted.

3.12 RISER CONDUIT ENTRANCE IN COMMUNICATIONS ROOMS – FLOOR ENTRY

A. Riser conduits shall enter the communications room floor two inches to four inches on center from the wall and shall stub up six inches AFF.

B. Conduit floor stubs shall be spaced in increments to equal the conduit OD from each other.

C. Riser conduits shall be installed in a single tier or row from left to right horizontally.
   1. If two tiers or rows are required, the conduits shall be staggered between tiers.
   2. No more than two tiers or rows are permitted.

D. Exiting cable shall be extended to the bottom of the cable tray and be provided with cable support anchors and secured with supporting hardware every six inches above the con- duit bushings.

E. Conduit floor stubs shall be extended 2 to 4 inches (101.6 mm) from wall on center and 4 inches above AFF.

F. The riser cable shall be extended in the cable tray to the terminating equipment, as noted in the Drawings.

G. Conduit crossovers are not permitted.

3.13 CABLE TRAY INSTALLATION

A. Cable tray shall be supported as follows:
   1. Where tray is suspended above equipment cabinets it shall be supported by a Tra- peze type hanger and per manufacture instructions. In all other applications, the tray shall be supported by uni-strut trapeze type hangers affixed to the structure above via minimum 3/8-inch threaded rod.
   2. Threaded rod shall be fitted with a 6-inch long tube where it resides in cable tray to protect cables.
   3. Minimum of 12 inches (304.8 mm) of vertical clearance above all cable tray.

B. Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment comply with require- ments of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines.

C. Provide sufficient space encompassing cable trays to permit access for installing and maintaining cables.

D. Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2 guidelines, or in accordance with manufacturer's instructions.

E. A support must be place within 24 inches (609.6 mm) on each side of a connection or fitting.

F. Maintain a minimum of 12 inches (304.8 mm) of clearance above cable tray for cable installation. Maintain a minimum of 3 inches (76.2 mm) between ceiling tile and cable tray support.

G. Cable tray installation will be completed in one continuous run with no separations be- tween sections.

H. Vertical cable or ladder racks shall be used to route cable up and down the wall.

I. Dropout/Water Fall of the same make and size of the cable tray shall be used to route cables in or out of the tray.

J. Matted “T” and elbows shall be used of the same make and size for all interchanges and directional changes

3.14 JUNCTION BOX/PULL BOX INSTALLATION

A. Pull boxes shall be installed in sections of conduit every 100 feet (3048 cm) in length, that contain more than two 90-degree bends, or that contain bends that are 180 degrees or more in the aggregate.

B. A pull box shall NOT be used in lieu of a conduit bends.

C. All pull boxes shall be installed in an easily accessible location with unobstructed entry to the pull box access panel.

D. Pull boxes shall be supported on all four corners in such a manner that the pull box is not supported by the cable running through or conduit attached to the pull box.

E. Horizontal Junction/Outlet Boxes
   1. Each horizontal conduit shall be terminated into an outlet box.
   2. Each outlet box shall be a deep four-inch square junction box with a minimum of two one-inch knockouts on bottom and each of the sides.
   3. Each conduit home run shall be provided with a deep 4-inch square junction box (w/cover) at 100-foot intervals and six inches above each ceiling and wall intersec- tion.

3.15 CABLE HOOK INSTALLATION

A. Installation and configuration shall conform to the requirements of the ANSI/TIA Standards 568A & 569, NFPA 70 (National Electrical Code), and applicable local codes.

B. Cable hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.

C. Cable Hook spacing maximum 5 feet (152.4 cm) on center.

D. Maintain maximum cable sag between cable hooks of 12 inches (304.8 mm).

E. Cable shall not touch ceiling tile or light fixtures. Provide minimum 3” vertical separation above ceiling tiles.

F. Do not fill cable hook greater than manufactures recommended guidelines, maximum 40% fill.

3.16 FIRESTOPPING MATERIAL INSTALLATION

A. Comply with manufacturer’s product data, including product technical bulletins, product catalog installation instruction, and product carton instruction for installation.

B. Verify substrate conditions are acceptable for product installation in accordance with manufacturer’s instructions.

C. Install fire stopping to comply with performance requirements specified herein.

D. Install fire stopping to comply with listed fire rated assemblies in accordance with ASTM and UL requirements

E. Installer shall be trained and approved by the manufacturer

F. Protect installed products from damage during construction operations until final completion.

G. Inspection: Code official or building inspectors to review proper installation using manufacturer guidelines.

3.17 LABELING

A. All communication pathway components shall be properly labeled.

B. Refer to section 270553

3.18 GROUNDING AND BONDING

A. Refer to Section 270526.

3.19 ACCEPTANCE

A. Refer to Section 270000.

END OF SECTION

SECTION 270543
EXTERIOR PATHWAYS FOR COMMUNICATIONS SYSTEMS

GENERAL

1.01 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2025.

B. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures; 2020.

C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

D. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.

E. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.

F. Subject to the General and Special Conditions, this section shall specify underground ducts, and utility holes designated as maintenance holes, and hand holes.

1.02 SECTION INCLUDES:

A. Rigid steel conduit.

B. Plastic conduit.

C. Plastic duct.

D. Utility holes, maintenance holes (MH), hand holes (HH)

E. Underground duct markers.

F. Division 31 – Trenching & Backfilling: Execution requirements for trenching, backfill and compaction required by this section.

1.03 REFERENCES

A. Section 270000 inch (6858000 mm) its entirety shall be included as part of this specification.

1.04 RELATED SECTIONS:

A. Div 01

B. Section 270526 Grounding and Bonding for Communications Systems

C. Section 270543 Exterior Pathway for Communications Systems

D. Section 270553 Identification for Communications Systems

E. Section 271100 Communications Equipment Room Fittings

F. Section 271300 Communications Backbone Cabling

G. Section 271500 Communications Horizontal Cabling

H. Section 272100 Data Communication Network Equipment

1.05 DESCRIPTION

A. Interconnected system of encased conduits, ducts, MH, and HH to distribute medium-voltage power, low-voltage power, data communications, and video.

B. Conduit and duct routing and utility hole locations are shown in approximate locations unless dimensions are indicated. Field route and locate to complete duct bank system.

C. Underground Ducts:

D. Medium-voltage: Use rigid plastic underground conduit.

E. Low-voltage: Use rigid plastic underground conduit.

F. Data communication: Use rigid plastic underground conduit.

G. Above ground conduit shall be rigid, hot-dipped galvanized steel manufactured according to UL and ANSI No. C80.1, threaded before galvanizing. Install according to NEC and AISI Handbook for Steel Electrical Raceways.

H. Conduit size shall be as indicated on the Drawings.

1.06 COORDINATION

A. Refer to General or Special Conditions.

B. Refer to Division 26, Electrical Work

C. Coordinate Work with existing underground utilities and structures.

1.07 QUALITY ASSURANCE

A. Refer to section 270000

B. Verify duct banks do not interfere with existing or new underground facilities.

C. Assure that the "as installed" system is correct and complete per construction documents: including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.

D. Owner/Architect/Engineer retains the right to access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at the expense of the contractor.

E. UL Compliance: Provide products that are UL-classified and labeled.

1.08 SUBMITTALS

A. Refer to section 270000

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped.

B. Store nonmetallic ducts with supports to prevent bending, warping, and deforming

C. The contractor shall endeavor to make the site ready for installation of manholes when delivered so that they can be placed off of the truck into final position.

D. When this is not possible, store precast concrete and other factory-fabricate underground utility structures as Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

E. Lift and support precast concrete units only at designated lifting or supporting points.

F. Clearly mark containers "For Communications Duct Banks Only".

G. Refer also to section 270000

1.10 WARRANTY

A. Refer also to section 270000

1.11 MAINTENANCE

A. Refer also to section 270000

PRODUCTS

2.01 RIGID STEEL CONDUIT: ANSI C80.1.

A. Fittings: NEMA FB 1, steel.

2.02 PLASTIC CONDUIT AND DUCTS

A. Rigid Plastic Conduit: NEMA TC 2, Schedule 40 PVC, with fittings and conduit bodies to NEMA TC 3.

2.03 MAINTENANCE HOLE (MH)

A. Nominal Inside Dimensions: 3’H x 3’W x 3’L

B. Oldcastle polymer 3636 or approved equal.

2.04 MAINTENANCE HOLE SHALL INCLUDE THE FOLLOWING:

A. Description: Pre-cast concrete utility hole with standard duct entrance configuration or multi-knockout panels.

B. Minimum ANSI Tier 22 rating

C. Furnish cover marked “TELECOM MH##” for communications with Manhole No..

D. Repair chipped knockouts with grout.

E. Seal all unused knockouts and spare ducts with duct plugs

F. Segmented Thin Wall Knockouts

G. Flush Solid Cover

H. Penta Head Bolt

I. Penta Coil Thread Bolt

J. Captive Bolt Retainer

K. EMS Marker (E)

L. Mouseholes/Knockouts

M. Rack Mount

N. Cable Racks/Cable Arms

O. Unistrut

P. Pulling Eye - 1,000 lb and 3,000 lb

Q. Ground Buss (F)

R. Dividers

S. Racking Provision

T. Lid Gaskets*

U. Solid Bottom

V. Custom Marking Plate (Polymer)

2.05 HAND HOLE (HH)

A. Nominal Inside Dimensions: 2’x3’x3’

B. Oldcastle polymer 2436 or approved equal.

2.06 HANDHOLE HOLE SHALL INCLUDE THE FOLLOWING:

A. Description: Pre-cast concrete utility hole with standard duct entrance configuration or multi-knockout panels.

B. Minimum ANSI Tier 22 rating

C. Furnish cover marked “TELECOM MH##” for communications with Manhole No..

D. Repair chipped knockouts with grout.

E. Seal all unused knockouts and spare ducts with duct plugs

F. Segmented Thin Wall Knockouts

G. Flush Solid Cover

H. Penta Head Bolt

I. Penta Coil Thread Bolt
J. Captive Bolt Retainer
K. EMS Marker (E)
L. Mouseholes/Knockouts
M. Rack Mount
N. Cable Racks/Cable Arms
O. Unistrut
P. Pulling Eye - 1,000 lb and 3,000 lb

2.07 UNDERGROUND DUCT MARKERS

A. Underground Warning Tape: 4-inch wide detectable plastic tape 6 mil (0.1524 mm) thickness min.) with warning label stating, “CAUTION: BURIED COMMUNICATIONS LINE.”
B. Follow NESC411E, and NEC300.50
C. Metallic tape or metallic strip for above ground detection
D. Orange tape for Communications line

2.08 MANUFACTURERS

A. Conduit Measuring Tape:
B. Neptco
C. Greenlee
D. Garvin Industries

2.09 CAUTION TAPE:

A. Reef Industries
B. Repnet
C. Panduit

2.10 MAINTENANCE/HAND HOLE COVERS

A. Oldcastle
B. Locke Solutions
C. Neehan Foundry
D. Dabico Inc.
E. Inland Foundry

2.11 FLEXIBLE MULTI-CELL INNERDUCT

A. Manufacturers:
    1. MaxCell
    2. Or OWNER approved equivalent

2.12 FLEXIBLE INNERDUCT

A. Flexible innerduct is the OWNER standard for multi-path applications within conduit.
B. All backbone fiber shall be installed in flexible innerduct.
C. Flexible Innerduct shall be UL Listed with Flame Propagation compliant with UL 2024A.
D. All flexible innerduct shall be installed per manufacture requirements.
E. Only manufacturer’s fittings, transition adapters, terminators, accessories, and installa- tion kits shall be used.
F. All flexible innerduct will be populated with a measured pull tape.

G. All interior flexible innerduct shall be plenum rated.

H. Flexible innerduct shall only be used when installed in conduit and shall consist of a dif- ferent color for the Maxcell.

I. Design consultant shall specify/select the proper size Maxcell products to meet the pro- ject requirements.

Min Con- duit ID	Suggested Product	Number # of Packs	Max # of Cables	Maximum Ca- ble Diameter per Cell	Rec. Pull Length*	Max Pull Length*
3"	MaxCell 4" 3-Cell	1	3	1.34"	1500'	2000'
4"	MaxCell 4" 3-Cell	2	6	1.34"	1500'	2500"

a. *Use of Optical Fiber Nonconductive Riser (OFNR) cable may result in reduced pulling lengths

2.13 CONDUIT PULL LINE

A. Minimum pulling tension greater than 900 lb.

B. Ready-to-use cable pull line,

C. Use directly from the container.

D. Resists tangling when dispensing.

E. Rot and mildew resistant.

F. Handy reusable plastic dispenser pail with handle keeps the line dry.
1. Neptco #WP900P or approved equivalent.

EXECUTION

3.01 EXAMINATION

A. Refer to General Conditions regarding verification of existing conditions before starting work.

B. Verify routing and termination locations of duct bank prior to excavation for rough-in.

C. Verify locations of utility holes prior to excavating for installation.

3.02 PREPARATION

A. Verify materials are on site in proper condition and of sufficient quantity.

B. Before encasement, verify ducts are free of debris and properly installed in support and spacer system, are properly fitted together and hold-down hardware is properly installed.

3.03 INSTALLATION

A. Install all work following drawings, manufacturer’s instructions and approved submittal data.

B. The minimum depth of a trench must allow 36 inches (914.4 mm) of cover from the top of the duct bank to the final grade point.

C. The following minimum vertical or horizontal separations must be maintained between tele- communications facilities and other facilities sharing a common trench.

D. Power or other foreign conduits: 3 inches (76.2 mm) of concrete, 4 inches (101.6 mm) of masonry, or 12 inches (304.8 mm) of well-tamped earth.

E. Pipes such as gas, oil, water: 6 inches (152.4 mm) when crossing, 12 inches (304.8 mm) when parallel.

F. Railways: 3 feet (91.44 cm) below top of rails.

G. Conduit must be encased in concrete when the following conditions exist.
   1. Reinforcing bars and or crutches within the concrete must be used at any location subject to potentially extreme stress.
   2. Minimum conduit depth cannot be attained.
   3. Conduit must pass under roads, driveways, railroad tracks, or when bend points are subject to movement.

H. The inside-the-building end of the conduit must be sealed to prevent rodents, water, or gases from entering the building.

I. Install watertight penetrations through foundation, HH and MH walls. Wherever a hand hole is used to simply pass through, the conduit entrances and exits will be situated at opposite ends of the hand hole instead of 90 degree angles.

J. Provide reinforcement at the point where ductbanks enter manhole or building walls as required to sustain shear forces that may be exerted on the ductbank by soil settlement or heaving.

K. Reinforcement may consist of PVC-coated or tape-wrapped galvanized rigid steel (GRS) or heavy-wall fiberglass-reinforced (FRE) conduits 10 feet (304.8 cm) out from the inside face of the man- hole, tunnel, or building wall.

L. Specify end bells manufactured of GRS or heavy-wall fiberglass at the points of penetration/termination.

M. Assemble duct banks with non-magnetic saddles, spacers and separators. Position separators for 2-inch minimum concrete separation between outer surfaces of adjacent ducts.

N. All bends must be long, sweeping bends. Make uniform required bends with a minimum of a 24 inch (609.6 mm) radius for conduits less than 3 inch (76.2 mm) diameter, and a 48 inch (1219.2 mm) radius for conduits 3 inches and larger.

O. Maintain vertical or horizontal separations of 12 inches (304.8 mm) of well-packed topsoil from any electrical service conduit run parallel to Communications conduits.

P. Extend below grade conduits to 4 inches (101.6 mm) above the finished floor inside a building.

Q. Install conduit and duct with minimum slope of 4 inches (101.6 mm) per 100 feet (3048 cm). Slope conduit and duct toward manholes and away from building entrances.

R. Cut conduit and duct square using saw or pipe cutter; de-burr cut ends.

S. Insert conduit and duct to shoulder of fittings; fasten securely.

T. Join nonmetallic conduit and duct using adhesive as recommended by manufacturer.

U. Wipe nonmetallic conduit and duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

V. Install no more than equivalent of three 90-degree bends between pull points for electrical conduits and two (2) 90-degree bends for communications conduits.

W. Install fittings to accommodate expansion and deflection.

X. Terminate conduit and duct at manhole entries using end bell.

Y. Stagger conduit and duct joints vertically in concrete encasement six (6) inches minimum.

Z. Use suitable separators and chairs installed not greater than 4 feet (121.92 cm) on centers. Secure separators and chairs to trench bottom prior to concrete pour.

AA. Band conduits and ducts together before backfilling or placing concrete.

BB. Securely anchor conduit and duct to prevent movement during concrete placement.

CC. Place concrete in accordance with Section 03 3000.

DD. Install ducts with minimum 3 inch (76.2 mm) concrete cover at bottom, top, and sides.

3.04 REINFORCING STEEL:

A. Reinforcing steel shall have a minimum yield strength of 60,000 psi (413685.60 kPa) for No. 4 bars and smaller, and 60,000 psi for No. 5 bars and larger.

B. The reinforcing steel shall run parallel in the underground duct bank with one No. 4 0.5 inch (12.7 mm) diameter) bar at each corner of the duct bank, lapped 24 diameters at splices.
   1. Install two No. 4 steel reinforcing bars in top of bank under paved areas.

C. Connect to manhole wall using dowels.

D. Provide suitable pull string in each empty duct except sleeves and nipples.

E. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.

F. Backfill trenches in accordance with Division 31.

G. Interface installation of underground duct markers with backfilling specified in Division 31.

3.05 PRE-CAST UTILITY HOLE

A. All pull boxes, hand-holes, man-holes, and utility holes shall be dedicated for either electrical or communications. Under no circumstances shall electrical cables and communication cables be installed in the same box.

B. Install and seal precast sections in accordance with ASTM C891.

3.06 INSTALL UTILITY HOLES PLUMB.

A. Size hand-hole in accordance with NEC unless noted otherwise on drawings.

B. Backfill utility hole excavation

3.07 CLEANING

A. Refer to section 270000

3.08 LABELING

A. All communication pathway components shall be properly labeled.

B. Refer to section 270553

3.09 GROUNDING AND BONDING

A. Refer to Section 270526.

3.10 ACCEPTANCE

A. Refer to Section 270000.

END OF SECTION

SECTION 270553
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

GENERAL

1.01 REFERENCE STANDARDS

A. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2021d.

1.02 THIS SECTION INCLUDES THE FOLLOWING:

A. Identification requirements for communications systems

1.03 RELATED SECTIONS:

A. Div 01
B. Section 270526 Grounding and Bonding for Communications Systems
C. Section 270528 Interior Pathways for Communications Systems
D. Section 270543 Exterior Pathway for Communications Systems
E. Section 271100 Communications Equipment Room Fittings
F. Section 271300 Communications Backbone Cabling
G. Section 271500 Communications Horizontal Cabling
H. Section 272100 Data Communication Network Equipment

1.04 REFERENCES

A. Refer to section 270000.

1.05 QUALITY ASSURANCE

A. Refer to section 270000.

1.06 SUBMITTALS

A. Refer to sections 270000

1.07 DELIVERY, STORAGE, AND HANDLING

A. Refer to sections 270000

1.08 PROJECT/SITE CONDITIONS

A. Refer to section 270000

1.09 WARRANTY

A. Refer to section 270000

1.10 MAINTENANCE AND SUPPORT

A. Refer to section 270000

PRODUCTS

2.01 IDENTIFICATION (LABELING) SYSTEM

A. Brady
B. Dymo
C. Hellerman-Tyton
D. Or Equal

EXECUTION

3.01 GENERAL REQUIREMENTS

A. Label all cable, fiber strands, patch panels, patch panel termination positions, distribution frames, jacks, and cover plates.

B. Wire and fiber labels shall be clear vinyl with acrylic adhesive tape. Text shall be typed with minimum 8 point font.

C. All other labels shall be white polyester with acrylic adhesive tape. Text shall be typed with minimum 10 point font.

D. Label shall be attached to each copper cable at each end.

E. Label all conduit stubs.

F. Label all conduits and innerducts passing through MDF/IDF Rooms.

G. Provide front adhesive label for individual patch panel positions. Label patch panels consecutively from bottom to top. Label shall be typed with minimum font size of 8 point.

H. Label shall be attached to fiber cable at each end and to each individual fiber at each end prior to termination.

I. Cable labels shall be placed in the following locations: on jack face plates, on cable inside back boxes, junction boxes, access points, and manholes/handholds, on cable above the terminations in the IDF and MDF, on patch panels, and every 50 feet (1524 cm) when not in conduit. Con- duits shall be labeled “communications” every 50 feet and at the origination and destination.

3.02 NAMEPLATES

A. Provide engraved three-layer laminated plastic nameplates with white letters on a black background.

B. Provide nameplates for the following:
   1. Equipment Racks and cabinets.
   2. Telecommunication Grounding Busbars.
   3. Equipment Enclosure Boxes and Pull Boxes

3.03 COPPER CABLE 66/110 WIRING BLOCKS:

A. 66/ 110 wiring block shall be labeled on for individual pairs.

B. Label using Excel spreadsheet template, along with color transparent plastic strip (EFM) for color-coding.

C. Voice and data 110 wiring block labels will be distinguished by the following acronyms:
   a. Data Frame Example: Voice Frame Example:
   b. DT = Data Campus Cable VT = Voice Campus Cable DM = Data Backbone Cable VM = Voice Backbone Cable
   c. DL= Data Network Cable VP = Voice ISDN Power Cable DU = Data Horizontal Cable VU = Voice Horizontal Cable

D. Skip 25th position on each strip of 110 wiring block when wiring 4-pair cable.

E. Provide floor-standing frame labels assuming twelve 300-pair 110 wiring blocks. Group of blocks are to be designated as backbone cables, power cables, network cables, and horizontal voice or data cables.

F. Install nameplate on each floor-standing frame.

G. Label network equipment 110 wiring blocks with equipment number, slot, and port number.

H. Insert EFM color-coded plastic slides over 110 block labels.
   1. Lightguide Interconnection Unit (LIU)

I. Attach engraved label to door of LIU. LIU label shall have building number, IDF number, and numeric sequence.

J. List cable(s) and room number on LIU along with LIU name.

K. Provide continuous numbering sequence for individual fibers. Number individual fiber strands in LIU from 1 through 24, for cables with 24 fiber strands or less.

L. Use multiple LIUs for cables with greater than 24 fiber strands, and label sequentially according to number of fiber strands.
   1. Lightguide Termination Shelf

M. Label cable designation(s) on outside door of termination shelf.

N. Single shelf may hold more than one campus, backbone or horizontal cable. Do not split a single cable between shelves. Start numbering sequence from 1 within the shelf, and continue to last fiber strand within that cable, for cable larger than 4 fibers.

O. Label each individual coupler on coupler plate with appropriate sequential number for terminating shelves.

P. Each shelf shall contain either single-mode or multi-mode, not both.

Q. Install multiple shelves for cables greater than 72 optical fibers. Label sequentially according to number of optical fibers.

R. Label 4-fiber user cables according to number of couplers in the shelf.
   1. Conduit: Label conduits with appropriate color-coded tape.

S. Install tie wrap label tag on each conduit end point that terminates in IDF, MDF, or stubbed through floor, ceiling or wall without pullbox.

T. Printed letter with permanent black ink, in block type letters with clear, legible letters.

U. Match label information to information in nearest J-Box label that conduit leads to.

3.04 LABELLING SCHEME OVERVIEW

A. All Communications system components (racks, equipment, cables, etc.) shall be labeled per this documents and TIA-606 standard.

B. All labels shall be machine printed. No handwritten label is acceptable.

C. All labeling should be a unique identifier for the cabling infrastructure within a building and between buildings on a campus.

D. Submit the labeling scheme and text font type and size to Harris County IT and IT Consultant for review and approval before installation.

3.05 DATA OUTLET FACEPLATE AND PATCH PANELS

A. All Data ports on outlet faceplate and patch panels shall be labelled with the fol- lowing labelling scheme: RRR-Architect#
   a. RRR: Telecom Room ID. Match the final room numbering on architectural floor plans (e.g. for MDF Room 110 the room ID should be 110)
   b. #A: Patch Panel ID starting with the rack number “#” (1, 2, 3, etc.) and letter A, B, C, etc. from top down)
   c. ##: patch panel port number 01, 02, 03, etc.

3.06 COPPER PATCH PANELS

A. All patch panel ports shall be labelled with the following labelling scheme: Architect#
   a. RRR: Telecom Room ID. Match the final room numbering on architectural floor plans (e.g. for MDF Room 110 the room ID should be 110)
   b. #A: Patch Panel ID starting with the rack number “#” (1, 2, 3, etc.) and letter A, B, C, etc. from top down)
   c. ##: patch panel port number 01, 02, 03, etc.

B. Patch Panel ID: all the patch panel itself shall be labeled with panel ID: #A (see B.1.b above)

3.07 HORIZONTAL CABLES

A. All horizontal cables shall be labeled with the following labeling scheme: CAT6A- RRR-Architect#
   a. CAT6A: cable type (if Cat5e then it should be changed to “CAT5E”)

b. See section above for instruction on “RRR-Architect# ”
c. Provide a minimum of one (1) cable label at 2” to 3” from terminations at the outlet end, and one (1) at 12” to 18” from terminations at the patch panel end.

3.08 INTRA-BUILDING RISER CABLES

A. All intra-building riser cables shall be labeled with the following labeling scheme: FFF- ##ST-RRR-R#???=???TTT-R#
   a. FFF: fiber cable type (OM1, OM2, OS1, OS2, etc)
   b. ##ST: “##” indicates the cable strand count
   c. RRR: Telecom Room ID “RRR” (origination room number/ID, typically the MDF room)
   d. R#: rack ID. ”#”: 1, 2. 3, etc.
   e. TTT: Telecom Room ID “TTT” (destination room ID/number, typically the IDF rooms)

3.09 INTER-BUILDING BACKBONE CABLES

A. All inter-building backbone cables shall be labelled with the following labelling scheme: FFF-##ST-BBBBB-RRR-R#???=???CCCCC-TTT-R#
   a. FFF: fiber cable type (OM1, OM2, OS1, OS2, etc)
   b. ##ST: “##” indicates the cable strand count
   c. BBBBB: origination building ID, CCCCC: destination building ID (e.g. 611WK for 611 Walker Street bldg.).
   d. RRR: Telecom Room ID (origination room, typically the MDF room)
   e. R#: rack ID “R1”, “R2, “R3”, etc.
   f. TTT: Telecom Room ID (destination room, typically the IDF rooms)

3.10 EQUIPMENT RACKS/CABINETS

A. All equipment racks/cabinets shall be labeled with the following labeling scheme: R#
   a. #: rack number 1, 2, 3, etc.

3.11 WORK AREA IT DEVICES

A. All work area IT devices shall be labelled with a device tag using the following labelling scheme “DEP-BBBBB-WAP-001”, and MAC address “ MAC=00:1A:1E:C9:17:38”
   a. DEP: Department ID
   b. BBBBB: building/site ID
   c. WAP: Device type (WAP for WiFi Access Point, RSH for room scheduler, DSD (Digital Signage Device, etc.)
   d. 001: AP number starting from 001 at 1st floor entrance (by building)
   e. MAC=: indicates the numbers and letters following are for the MAC address

3.12 TELECOM ROOM EQUIPMENT

A. All Telecom Room equipment shall use the following labelling scheme: “DEP-BBBBB- RRR-UPS-001”
   a. DEP: Department ID
   b. BBBBB: building/site ID
   c. RRR: Telecom Room ID
   d. UPS: device type (UPS for uninterruptable power supply, NSW for network switch, PDU for power distribution units, etc.)
   e. 001: Device number (by building)

3.13 UNDERGROUND MANHOLES

A. All communications manhole (and handhole) covers shall use the following labelling scheme: “COMMUNICATIONS MH01”
   a. MH: Communications structure type
   b. 01: Device number (by campus)

3.14 COMMUNICATIONS CONDUITS/SLEEVES

A. All short run of communications conduits with clear visibility of their destination shall be labeled “DATA”.

B. All long run of communications conduits without clear visibility of their destination shall use the following labelling scheme: “DATA-MH01*{font-family:"Arial";font-size:10pt;}img{max-width:300px;max-height:300px;width:225px;height:225px;}span {white-space:pre; }
    a. DATA: indicate the intended use
    b. MH01: origination location (building ID if it’s between buildings, or telecom room ID

C. All sleeves for communications shall be labelled “DATA”

3.15 COMMUNICATIONS PULL BOXES

A. Use the following labelling scheme: “DATA-PB-001”.

3.16 TELECOM GROUNDING AND BONDING

A. All busbars shall be labeled with the following labeling scheme
    a. Primary Bonding Busbar: “PBB-##”
    b. Secondary Bonding Busbar: “SBB-##”
    c. Rack Bonding Busbar: “RBB-##”

B. All bonding conductors shall be labeled with a unique ID and origination/destina- tion. See below for the labeling scheme
    a. Bonding Backbone (from PBB to SBB/RBB or building service ground elec- trode): BBC-## PBB-01 to SBB-01”
    b. Equipment Bonding Conductor (from PBB/SBB to each equipment/devices): “EBC-## SBB-01 to EB-01” (EB-01: ID of equipment enclosure box)

3.17 ADMINISTRATION

A. Upon completion of the installation, Contractor will prepare as-built documentation of the entire Communications systems. This documentation should include:

B. Drawings
    1. All drawings shall be provided on disk in a form compatible with AutoCAD 2010. A complete set of project plans will be provided to the Contractor on disk. The Contractor will modify the drawings by placing the cable information on a separate layer. All of the requested drawings will be placed on these plans so that all cable routes are to scale and provide accurate information for use in the future when changes are made and the exact location of cables is required to avoid service interruptions.
    2. A complete diagram of all terminations in the Telecommunication Rooms and Closets
    3. A complete diagram of all copper, fiber, and coax riser cables.
    4. A complete diagram of all copper, fiber, and coax inter-building cable.
    5. Floor plans showing exact Data Outlet ID, and cable routings with each outlet clearly marked with cable number.
    6. Rack Elevations showing all rack-mounted devices, the rack ID, and patch panel ID.
    7. A complete diagram of all cable tray, conduits and conduit sleeves.

C. Documentation
    1. All cable inventory data documentation will be submitted in the designated Microsoft Excel 2010 format.
    2. Documentation on horizontal cable will include cable number and length of cable.
    3. Documentation on riser cable and interbuilding cable will include cable number, source and destination, type of cable, length of cable and number of pairs or fibers.

4. Complete cross-connect documentation is required. This information will include detailed documentation of all four pairs of each horizontal cable and every pair of all copper riser and inter-building cable and every fiber of fiber optic cable.

D. Final Reports - Copper UTP Cables and Optical Fiber: Final reports which confirm that cabling has been tested per shall be delivered within two weeks after completion of installation.
   1. Submit one hard copy and one diskette copy of final reports to A/E and provide one hard copy of cabling charts only in each IDF/MDF.
   2. Each report shall include the following:
      a. Completed outlet test forms bound in 3-ring notebook by order of room number for each IDF divided by Tenant.
      b. Copies of UTP and optical test equipment calibration/certification certificates.
      c. Copies of training certificates for test personnel.
      d. Written statement ensuring UTP and optical fiber performance of the entire installation for minimum period of 20 years from the day of acceptance.

END OF SECTION

SECTION 271100
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

GENERAL

1.01 PROJECT SCOPE SUMMARY

A. Subject to the General and Special Conditions, this section shall specify Communications Equipment Room Fittings.

1.02 SECTION INCLUDES:

A. Requirements for new Communication Equipment Rooms (MDF and IDF) and Enclo- sures.

B. Materials and installation of equipment racks/cabinets and equipment in MDF and IDF's.

C. Cable runway and cable support managers .

1.03 DESCRIPTION

A. Communications Equipment Room Fittings
   1. The minimum number of 4-inch sleeves that must be used is based on the total square feet and number of IT drops that the sleeves support. For planning purpose:
      a. Up to 25,000 sq feet (26.91066 sq cm) = two 4-inch sleeves
      b. 25,000 sq feet (26.91066 sq cm) to 50,000 sq feet (53.82131 sq cm) = three 4-inch sleeves
      c. 50,000 to 100,000 sq feet (107.64263 sq cm) = four 4-inch sleeves
      d. 100,000 to 300,000 sq feet (322.92788 sq cm) = five to eight 4-inch sleeves

B. Space for new outside plant copper and fiber cable and terminating hardware will be provided in the MDF. Minimum of 3-ft clearance shall be provided in the front, back and one side of the equipment rack(s).

C. Minimum size MDF based on the size of the area it's serving.
   1. Minimum = 10'x 10'
   2. Reference drawings for dimensions.

D. Minimum size IDF based on the size of the area it's serving will be 8' x10'

E. Buildout of MDF/IDF Rooms
   1. There must be continuous and dedicated environmental control (24 hours per day, 365 days per year) to ensure that temperature and humidity values are within ac- ceptable limits. If the facility is powered by a generator or other emergency power source then the dedicated HVAC system(s) within the MDF/IDF must also be pow- ered by the generator. Maintain the room temperature between 64° F and 81° F. Humidity range, noncondensing: 16 ºF DP to 59 ºF DP and 50% RH to 70% RH. Provide network monitored sensor (APC#AP9641) in each MDF/IDF room. The cool- ing load shall be based on equipment to be installed initially and future growth (as- suming that the equipment racks will be fully occupied eventually).
      a. Fan Coil Units are more desirable than split units. Fan coil units, condensation pipes/tubing, refrigerant pipes/tubing, and plumbing shall not be located in the
         1) MDF/IDF room. The MDF/IDF room shall have only supply and return ducts to maintain cooling efficiency.
      b. Split units are not desirable, but if used shall meet the following criteria: NO more than 6 inch (152.4 mm). of any plumbing pipes/tubing, including condensation and re- frigerant, shall be visible in communications rooms; All 6 in. of visible pipes/tub- ing shall be insulated; Split units shall have a drain pan placed below the units to catch and divert any and all condensation/water to protect the electronic and cable warranties.
   2. Ceiling height a minimum of 9 feet (274.32 cm) above finished floor (AFF). No drop (false) ceilings is allowed.

3. Flooring: The floor must be sealed concrete or antistatic floor tile bonded to ground using manufacturer-recommended hardware. Carpet flooring is not allowed.
4. Lighting in MDF / IDF, must have a uniform intensity of 70 Foot Candles when meas- ured 30 inches (762 mm) from the finished floor on all sides of equipment racks.
5. All light fixtures must be mounted a minimum of 8 feet (243.84 cm) 6 inches (152.4 mm) above the finished floor, and no light fixtures shall be mounted directly above the equipment racks/cab- inets or overhead cable trays. Provide light at both the front and back of the equip- ment racks. A minimum of one set of lights shall be an emergency light.
6. Minimum electrical in MDF/IDF rooms:
    a. A minimum of two dedicated 120V AC electrical outlets on separate branch circuits (one (1) L5-30R and one (1) 5-20R quad receptacles for each full height equipment rack, (1) NEMA L5-20R twist lock receptacle and (1) NEMA 5-20R quad receptacle for each half-height equipment rack) shall be provided above each equipment rack/cabinet (on the back side) at 7’6”AFF.
    b. Separate duplex 120V AC convenience outlets with NEMA 5-20R (for tools, test sets, vacuums, etc.) installed at least 18 inches (457.2 mm) above the finished floor at 6-foot intervals around perimeter walls.
    c. Provide power receptacles or hardwired power circuits for all wall mounted equipment.
    d. Provide dedicated electrical panels for all equipment inside or serving Telecom Rooms (MDF/IDF). fed from emergency power and a building UPS, if available.
7. Plywood Wallfield: Minimum of 3 walls must be lined with 3/4 inch (19.05 mm) fire rated plywood, 8 feet (243.84 cm) high, installed with the bottom at 12 inches (304.8 mm) from the finished floor. Paint the plywood with two coats of light color fire retardant paint. The paint color shall match the room finish color. Leave the fire rating stamp ex- posed after painting. The plywood must be securely fastened to the wall-fram- ing members. With offset flush or flat mounted fasteners.
8. Fire Protection: Fire protection shall be provided as per the applicable code. Con-sideration should be given to the installation of pre-action sprinkler or other dry fire suppression system, or no fire protection if enclosed by fire rated walls. If wet pipe sprinklers are installed, the sprinkler heads shall be provided with cages to prevent accidental operation, and drainage troughs shall be placed under the sprinkler pipes to prevent leakage onto the equipment or cabling within the room.
9. A floor rating greater than 1 psi (4.8 kPa) distributed loading. A floor rating greater than 8.8 kilonewton (kN) (2000 lbf) concentrated loading. The floor must be sealed concrete or antistatic floor tile bonded to ground using manufacturer-recom- mended hardware. Carpet flooring is not allowed.
10. Fully-open, secured, lockable doors that are at least 3-ft wide and 80-in tall.
11. Security: MDF and IDF rooms must be secured and controlled with a proximity card reader, and access must be restricted on a least privilege basis. Video surveillance
    a. camera shall also be provided inside each MDF/IDF room. Consult with HARRIS COUNTY IT for exact placement and orientation of the camera. Exceptions to this rule must be ap- proved by HARRIS COUNTY IT. A placard should be placed at all entrances to MDF/IDF rooms that reads as follows: “RESTRICTED AREA: Escort Required. Contact HARRIS COUNTY IT at (832) 393-0383”.
12. A Primary Bonding Busbar (PBB) in the MDF, Secondary Bonding Busbar (SBB) in the IDF and bonding conductors sized per ANSI J STD-607 A Standards.
13. Room Layout: The Standard MDF/IDF room layout is to have multiple floor standing standard height (7-ft) equipment racks (2-post) in a row centered on the wall (mini- mum 10-ft wide) opposite or perpendicular to the entrance wall . Provide overhead ladder tray along the perimeter of room and over the equipment rack row, and verti- cal cable managers (minimum 6” wide and 7-ft high) between equipment racks and each end of the equipment rack row. Vertical cable runway shall also be provided from end of

conduits/sleeves to horizontal ladder tray. Please note that exact num- ber of racks might be different for specific projects depending on quantity of Data cables and amount of equipment required.

14. Rack Elevations: in MDF/IDF room, backbone and riser cables, voice gateway and core switches shall be located in Rack #1. Rack#2 (and #3 if needed) shall be re- served for terminations of horizontal cables and edge switches. The top half of each rack shall be reserved for cable terminations (patch panels, fiber enclosures, etc.), and bottom half of each rack shall be reserved for active network equipment (switches, UPS, etc.).

1.04 REFERENCES

A. Section 270000 inch (6858000 mm) its entirety shall be included as part of this specification.

1.05 RELATED SECTIONS:

A. Div 01
B. Section 270526 Grounding and Bonding for Communications Systems
C. Section 270528 Interior Pathways for Communications Systems
D. Section 270543 Exterior Pathway for Communications Systems
E. Section 270553 Identification for Communications Systems
F. Section 271300 Communications Backbone Cabling
G. Section 271500 Communications Horizontal Cabling
H. Section 272100 Data Communication Network Equipment

1.06 COORDINATION

A. Refer to General or Special Conditions.
B. Refer to Division 26, Electrical Work

1.07 QUALITY ASSURANCE

A. Refer to section 270000.
B. Assure that the "as installed" system is correct and complete per construction documents: including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.
C. Owner/Architect/Engineer retains the right to access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at the expense of the contractor.
D. Provide shop drawings of equipment room layout and rack elevations for review and approval by HARRIS COUNTY IT and IT Consultant before installation to start.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Refer to section 270000.

1.09 SUBMITTALS

A. Refer to section 270000

1.10 WARRANTY

A. Refer to section 270000.
B. If items supplied as part of Project have warranties longer than one year from date of final acceptance, Contractor shall supply longer warranty.

PART 2 PRODUCTS

2.01 EQUIPMENT RACKS

A. Approved Manufacturers:

1. CPI or OWNER approved equal.

B. For floor standing racks, Include base flanges with mounting holes securing the rack to the floor. Each mounting hole must be at least 5/8” in diameter.

C. Where the rack is to be mounted to VCT flooring or bare concrete, an insulating pad must be used, and care must be taken that anchors, used to secure the rack to the floor, do not come in contact with any reinforcing steel embedded in the concrete slab.

D. Vertical and horizontal wire management shall be provided in each rack/cabinet.

E. Standard is to use floor standing 2-post racks in all MDF/IDF rooms, wherever possible. Cabinets are only used in place of equipment racks based upon security and cleanliness of the room to replace open frame racks.

2.02 FREE STANDING 2-POST RACK:

A. 2-Post rack shall be 7’ high 19” wide.

B. CPI # 55053-703 or OWNER approved equal.

2.03 FREE STANDING NETWORK CABINET:

A. Cabinets shall be fully assembled by the manufacturer with the components listed below. Individual component part numbers:
   1. Chatsworth 45RU; 800mm W; 1100mm D; ZetaFrame # ZB44-A1200-71
   2. 12-24 Tapped sliding rails / 2-pair
   3. Single perforated metal front door with swing latch w/padlock feature
   4. Double perforated metal rear door with swing latch w/padlock feature
   5. Gromet top panel, no bottom panel.
   6. Two solid two-piece side panels
   7. Black
   8. PDU Power Strips:
      a. Core Switch Cabinet QTY (2) Chatsworth Vertical eConnect Monitored Pro PDUs (Part # P4-1F0C3) Input Nema L6-30P; Output (18) C13s and (6) C19s. And (1) Horizontal Metered Power Strip (Part # 13239-755) Input Nema 5-20P; Output (12)
      b. Nema 5-20R
      c. All other Cabinets QTY (2) Chatsworth Vertical eConnect Monitored Pro PDUs (Part # P4-1D0A5) L5-30P input; output (24) 5-20Rs.
   9. Grounding Bus Bar:
      a. Provide Rack-Mounted Ground Bar. See Specification 270526

2.04 WALL MOUNTED CABINET:

A. CPI CUBE-iT 12419-748 (26RU, 24”W, 30”D, Black, Tempered Glass Door)

B. Or OWNER approved equal.

2.05 SLIDING SHELF

A. RackSolutions SKU#115-4779
   1. Provide one (1) per floor standing rack/cabinet and mount it at RU23, UON.
   2. Or OWNER approved equal.

2.06 CABLE MANAGEMENT

A. Approved Manufacturers:

B. CPI

2.07 VERTICAL CABLE MANAGEMENT:

A. Double-sided cable routing

B. 6” or wider depending upon application requirements

C. Lockable latching sections with protective edge guards

D. Space slots at 1 RU intervals
E. Black finish
F. CPI # 13912-703 (6”W, 45RU) or OWNER approved equal
G. CPI # 13914-701 (10”W, 45RU) or OWNER approved equal

2.08 HORIZONTAL CABLE MANAGEMENT:

A. Capable of attachment to a 19” rack
B. 2 U, maximum 4” deep
C. Heavy-duty aluminum rings with rounded edges
D. Incorporate cable routing guides and supports on rear panel
E. Black finish
F. CPI# 35431-702 (Motive 2U) or OWNER approved equal

2.09 CABLE RUNWAY

A. Use in MDF and IDF
B. Specifications
C. UL Classified for suitability (as an equipment grounding conductor only)
D. Minimum 12” wide
E. Support at 5’ intervals
F. Install at 7’ AFF
G. Secure to equipment racks with approved hardware
H. Crossmembers at 9” intervals
I. 10-foot sections
J. Bond to PBB/SBB per TIA-607 standard.

2.10 PRODUCTS

A. Universal Cable Runway: CPI # 10250-712 (12”W)
B. Runway Elevation Kits: CPI # 10606-706 (4”, 5” or 6” elevation)
C. Runway Radius Drop-Stringer: CPI # 14305-701
D. Runway Radius Drop-Cross Member: CPI # 14304-712
E. Runway Retainer Post-8”H: CPI # 10596-708
F. Include required accessories for a complete cable runway inside MDF and IDF
G. Provide other sizes as needed to meet the project requirements.

2.11 PLYWOOD WALLFIELD

A. All wallfield plywood shall be minimum 8’ x 4’ x ¾” fire rated unless noted otherwise.
B. Paint all backboards with a minimum of 2 coats of fire-retardant paint on all sides and edges.
C. For all new IDF or MDF Rooms, provide plywood on a minimum of 3 walls with 8’ high x ¾” plywood backboard or as noted on the contract documents.
D. Paint plywood backboard in light color that shall match the wall finish color, and leave the fire stamps exposed.

2.12 GROUNDING

A. All equipment, racks/cabinets, runway, armored cables shall be properly grounded/bonded to the PBB/SBB in accordance with the TIA-607 standard.

PART 3 EXECUTION

3.01 GENERAL

A. Telecommunications rooms are generally considered a zone serving facility. These rooms may be equipped with fiber and copper cables, wall mounted termination blocks/patch panels, rack mounted copper and fiber patch panel terminations, vertical and horizontal cable man- agement systems and equipment racks. Cable Contractor shall provide proper identifica- tions/labeling scheme for all structured cabling components installed in these rooms.

B. Follow manufacturer’s recommended installation and termination practices.

C. Cabling within racks and enclosures: provide adequate length of cabling. Train conductors to termination terminal points that follow manufacturer’s installation procedures for maintaining cable performance specifications. Provide lacing/mounting bars to restrain cables, to prevent straining connections, and to stop bending cables to smaller radii than minimums recommended by manufacturer.

D. Equipment Racks: Provide 19” wide x 7'-0” tall racks with number of vertical rack sections as required to allow space for all equipment, cabling and horizontal cable managers, plus space for future growth (minimum 25%).

E. Locate/space racks and enclosures (cabinet) according to TIA guidelines for front and around access.

F. Vertical wire management: double-sided vertical rack cabling sections shall be a minimum width of 6 inches (152.4 mm) or wider. Reference T. Drawings

G. Entrance: Arrange and coordinate locations of distribution frames, patch panels, cross- connections (furnished by others) in communication rooms and racks to optimize space requirements of any service provider requirements, telephone system and LAN equipment.

H. Provide cable runway in equipment room above all racks and up to cross- connects/runway/conduits/sleeve's entering room from corridors. Form a complete runway system by ringing the room and connecting all hardware installations. Route the cables within the room by taking the longest available path through the perimeter cable tray. Attach grounding lugs to each rack/cable raceway, conduit, etc. Refer to 'T' drawings for details.

I. The MDF contains cross-connect facilities for terminating cables and for connecting the horizontal and riser segments and telecommunications equipment. The MDF may also support other building information systems such as security, audio, and other telecommunications systems.

J. Coordinate runway locations with lighting, air-handling systems, and fire extinguishing systems so that fully loaded trays will not obstruct or impede their operation. In the United States, NEC Article 392 provides requirements for cable trays.

K. Provide horizontal cable runways. Equip each 19” rack with overhead ladder style cable runway installed between the wall and horizontal/equipment racks. Refer to COMMUNICATIONS “T” drawings for proposed locations and sizing of each runway.

L. Securely attach to wall studs with support brackets (and racks if applicable), in accordance with manufacturers written instructions.

M. Provide ground lug for each 19” rack. Racks shall be grounded to wall mounted ground bus bar using #4 AWG stranded, green jacketed, insulated copper conductor. Furnish all required bonding material and hardware, and bond PBB in MDF to building grounding electrode subsystem. If crimp connectors are used to bond the #6 AWG wire, follow NEC bonding procedures/specifications.

N. An inert dielectric material shall separate dissimilar metals apt to corrode through electrolysis under the environmental operating conditions specified.

3.02 EXAMINATION

A. Verify conduit, raceways, boxes, fittings and bodies are properly installed as specified in Division 16.

B. Verify grounding and bonding following Section 270526 and this section.

C. Verify supporting devices are properly installed following Section 270526.

D. Verify conduit has a minimum 1-inch diameter for Category 6 home runs.

E. Verify 4 inch (101.6 mm) or 6 inch (152.4 mm) conduits are used for building entrance cables or cables going between closets or buildings.

F. Verify liquid-carrying pipes are not installed in or above voice and data system equipment rooms.

G. All electrical circuits used for the connection of technology equipment should be dedicated single fused 120 volt 20 or 30 amp circuit. These outlets should be served from dedicated panels within the nearest electrical room. All of these outlets should be on an emergency backup power system to provide continuous uninterrupted power to the equipment.

H. All 120-volt circuits should be clearly marked and dedicated for technology.

I. All telecommunications rooms, MDF's and IDF's should not be located adjacent to any space that contains sources of Electromagnetic Interference (EMI). Transformers shall not be placed in any telecommunications closet and should be located at least 4 feet (121.92 cm) away from any com- munication cable or termination equipment.

J. All protected telecommunication terminations require bonding, grounding and a Busbar.

K. Flooring in Telecommunication Rooms shall be anti-static vinyl tile with vinyl baseboard as specified in Division 09.

L. Telecommunication rooms will have open ceilings at a minimum height of 9' with all exposed concrete sealed to prevent dust.

3.03 PREPARATION FOR IT EQUIPMENT INSTALLATION IN MDF/IDF ROOM

A. All communication rooms that will service the area to be opened must be completed. That means a final walkthrough of these areas has been completed. It is not necessary that the entire project achieve substantial completion, but IT equipment installation can not begin until the following minimum criteria is met:

B. Space is built out and vacuumed clean – free from debris and dust.

C. Electrical installation is complete and meets the County IT standard.

D. All racks/cabinets with vertical/horizontal managers) are installed and grounded/bonded/labeled.

E. The grounding busbar is installed/labeled and properly tied to the main grounding bus bar in MDF

F. HVAC is installed and functioning properly and is adequately filtering dust. Temperature and humidity can be monitored and controlled.

G. Door access control (card reader, cyberlock -or- an approved temporary provision)) is installed and operational. Simple key access is not permissible.

H. Lighting is installed and operational.

I. Cable trays/ladder racks are installed and grounded/bonded.

J. Permanent or temporary signage identifying the permanent room number.

K. All cabling necessary to operate the areas to be opened is completed.

L. Backbone cabling (copper and fiber) from the applicable communication room(s) is in- stalled, tested, labeled, and approved by the inspector and communications design con- sultant.

M. Horizontal cabling for all areas to be occupied is installed, tested, labeled, and approved by the inspector and communications design consultant.

N. Copper cross-connects and/or fiber jumpers have been installed per the owner/tenant requirements.

O. Cable test report and redline drawings for installed cables are submitted and approved. PRIOR to putting any active circuits on the new cables. Cable test report and cable IDs shall reflect all installed cables **and** any cross-connects, or jumper assignments in- stalled by the contractor.

P. All jumpers and patch cords specified by the contract are turned over to HARRIS COUNTY IT.

Q. NOTE: cable labels and permanent room numbers need to match. GC needs to be sure to get design team, Owner, HARRIS COUNTY IT, and Communications Contractor reps together to review permanent room numbers prior to installing cable labels.

R. Move-in buffer period needs to be a minimum of 6 weeks for HARRIS COUNTY IT and it's contractor to in- stall/extend services within the area to be occupied prior to occupation of the facility or spaces. Additional time may be necessary if Tenant IT organization is involved, or if the contractor has other systems that must be configured/tested and require HARRIS COUNTY IT resources (i.e. cabling or data network connections). This is frequently the case for PA System, Building Automation System, television, radio, Fire Alarm, pay telephone, Intrusion Alarm, access control & CCTV, etc.

S. Once HARRIS COUNTY IT accepts a communications equipment room and begins to install/configure equip- ment in preparation for hosting live applications, this room becomes a restricted area with access to be controlled by HARRIS COUNTY IT. Contractors must be substantially complete with systems inside the communications room so that access is generally not required. Minor punch list and scheduled testing with escort can be arranged, but access will be very limited.

3.04 INSTALLATION

A. Install work following drawings, manufacturer's instructions and approved submittal data. The number of cables per run, outlet configuration and other pertinent data will be included on the drawings.

B. All installation shall be done in conformance with TIA 568B and BICSI standards. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines will require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.

C. The Structured Cabling System (SCS) installation should meet all applicable national and local codes pertaining to low voltage cable system installations.

D. The contractor will adhere to the installation schedule of the general contractor and should attend all construction meetings scheduled by the general contractor.

E. The contractor will be responsible for the cross connection of the horizontal cable runs to the backbone cable system. The connection to voice and data systems will be performed by the vendors installing and/or maintaining those systems.

F. All components of the cabling system shall be installed in a neat, workmanlike manner. Wiring color codes will be strictly observed and terminations shall be uniform throughout the installation. All cables shall be neatly dressed at the termination points. Final installation shall be subject to the Engineer's approval.

G. Any cable placed in space used as an air return or in any way connected with air-handling plenums or building ventilation shall be low-smoke, fire retarding cable, and must comply with

the NEC 725, 760, and 800. No cabling shall be placed in plenums without written approval from the County Engineer.

H. All vertical cables shall be affixed to a permanent structure at each floor in accordance with industry standards to avoid cable pull back.

I. All conduit and cabinet entrances shall be sealed with an approved, re-enterable sealant material to prevent ingress of water, dust, or other foreign materials.

J. The Contractor shall conceal all horizontal distribution wiring within conduit provided in the walls. If it becomes necessary to use an alternative method, the Contractor shall obtain approval from the Owner prior to the use of the alternate method.

K. Install work following drawings, manufacturer's instructions, and approved submittal data.

L. The installation shall meet all applicable national and local codes pertaining to low voltage cable system installations.

M. The contractor will provide service loops (slack) for cables terminating in the main equipment room or the telecommunications closets. A 6- foot service loop will be provided above the access ceiling or cable trays unless specified otherwise. This will allow for future changes or expansion with having to install new cables.

N. The installation will include coordination, testing and problem resolution with the system vendors.

O. Provide any necessary screws, anchors, clamps, tie wraps, distribution rings, miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the cable plant system.

P. Furnish any special installation equipment or tools necessary to properly complete the installation.

Q. Failure to follow the appropriate guidelines may require the installer to provide additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the installer during the implementation.

R. Plug conduits where cabling has been installed in the main equipment room, backbone and other cable entrance locations with re-enterable duct seal of flame retardant putty.

S. All wiring, materials, and equipment must be listed and labeled by a nationally recognized testing laboratory. Original Equipment Manufacturer (OEM) documentation must be provided to the Owner, which certifies performance characteristics which meet TIA 568 Standards.

T. All techniques and fixtures must result in ease of maintenance and ready access to all components for testing measurements. No self tapping screws shall be used. All parts shall be made of corrosion resistant material, such as plastic, anodized aluminum or brass.

U. All materials used in installation shall be resistant to fungus growth and moisture deterioration. Dissimilar metals apt to corrode through electrolysis under the environmental operating conditions specified shall be separated by an inert dielectric material.

V. Provide firestop at all fire rated penetrations.

W. Field coordinate exact feeder, tie and riser backbone cabling pathways with other trades prior to construction. All existing pathways shown are suggested routes for the contractor to use as a guideline. The contractor is required to coordinate the exact pathway. In any case where the communication pathway must be removed and re-routed due to conflicts with other trades which were not previously coordinated with all building trades, the contractor is responsible for all costs associated with the removal and relocation.

X. Provide reducer brackets in all 23" cabinets and/or racks full length of rack for installation of 19" equipment.

Y. Provide bushings on all conduit ends.

3.05 DATA RELAY RACK

A. Bolt rack to floor.

B. Mount racks end to end in single continuous row with vertical wire managers located full length of rack between each end and on each row end.

C. Provide horizontal wire managers as follows:
   1. Front/Rear: Between each 24 port copper patch panel.
   2. Front: Between each 24 port network switch.
   3. Locate plug strips in racks with electronics.

3.06 HORIZONTAL CABLE ROUTING AND SUPPORT

A. The cable shall be routed un-exposed above the ceiling with 12" of clear space above route whenever possible.

B. Conduit runs shall not exceed two 90-degree bends or 100 feet (3048 cm) without a pull box.

C. All conduit located in the ceiling shall protrude 2 inches (50.8 mm) into the closet. Provide bushing on conduit end. Label all conduit ends and cables inside or passing through MDF and IDF Rooms.

3.07 LABELING

A. Refer to section 270553

3.08 GROUNDING AND BONDING

A. Refer to section 270526

3.09 CLEANING

A. Clean rooms after each installation phase of the Project so that construction debris or installation debris are removed continuously as the Project progresses and new equipment being installed is not contaminated from existing construction dust or debris.

B. Provide final cleaning of room, cabinets, and equipment prior to inspection by Engineer.

3.10 ACCEPTANCE

A. Refer to section 270000

END OF SECTION

SECTION 271300
COMMUNICATIONS BACKBONE CABLING

GENERAL

1.01 REFERENCE STANDARDS

A. ICEA S-83-596 - Indoor Optical Cable; 2021.

B. ICEA S-87-640 - Standard for Optical Fiber Outside Plant Communications Cable; 2023.

C. TIA-526-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 Edition 2: Fibre-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement; 2015a (Reaffirmed 2022).

D. UL 1666 - Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts; Current Edition, Including All Revisions.

E. Subject to the General and Special Conditions, this section shall specify.

1.02 SECTION INCLUDES:

A. This Section includes all the backbone cable specifications for the installation of a Struc- tured Cabling System (SCS) for the purpose of supporting voice and data communica- tions.

1.03 RELATED SECTIONS:

A. Div 01

B. Section 270000 Communications

C. Section 270526 Grounding and Bonding for Communications Systems

D. Section 270528 Interior Pathways for Communications Systems

E. Section 270543 Exterior Pathway for Communications Systems

F. Section 270553 Identification for Communications Systems

G. Section 271100 Communications Equipment Room Fittings

H. Section 271500 Communications Horizontal Cabling

I. Section 272100 Data Communication Network Equipment

1.04 SYSTEM DESCRIPTION

A. All backbone cables connecting MDF’s to IDF’s within a single building shall utilize armored fiber optic cable of type Singlemode Fiber (SMF), plenum rated. Strand count shall be a minimum of 12-strand per span or the number of required strands plus 50%, whichever is greater.

B. All backbone cables interconnecting separate buildings shall utilize indoor/outdoor armored fiber optic cable of type single-mode Fiber (SMF). Strand count shall be a mini- mum of 24-strand per span or the number of required strands plus 50%, whichever is greater.

C. If MPOE is located in a separate room, the backbone cable from MPOE to the MDF room shall include a minimum of one (1) 24-strand singlemode fiber cable.

D. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing, unless otherwise specified, in performing the following operations recognized as necessary for the installation, termination, and labeling of copper backbone infrastructure as described on the Drawings and/or required by these Specifications.

E. Approved cable manufacturers are Corning for fiber cables . All fiber cables shall be single-mode, unless noted otherwise. All fiber

F. There shall be no proprietary connectivity parts, each cable manufacturer shall use connec- tivity parts associated with their respective “partners”. All connectivity be in a nonproprietary

"keystone" style footprint. Jacket color shall be yellow for Singlemode fiber (black for OSP cables).

1.05 REFERENCES

A. REFER TO SECTION 270000

1.06 SUBMITTALS

A. Refer to section 270000

1.07 CABLE PULLING PLAN

A. The contractor shall submit a cable pulling plan prior to installation.

B. Submittal requirements:
   1. Indicate the installed backbone conduit layout in schematic format, including junction boxes and distances between junction boxes.
   2. Indicate contents of each conduit.
   3. Indicate the cable pulling calculations, conduit fill ratios and actual cable runs and tensions.
   4. Include detail and schedule showing the construction sequence of communications rooms.
   5. Installation of cabling shall not commence prior to approval of the pulling plan and calculations by the engineer.

1.08 SPLICE PLAN

A. The contractor shall submit shop drawings indicating the intended cable splice points, mounting method and equipment list prior to installation.

1.09 CABLE TESTING PLAN

A. Refer to Section 270000

1.10 CABLE TESTING REPORTS

A. Refer to Section 270000

1.11 QUALITY ASSURANCE

A. Refer to section 270000

B. Cable splicing personnel shall have a minimum of five years splicing experience and shall have completed a minimum of five major splicing projects.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Refer to section 270000

B. Storage temperature range: -40°F to 149°F (-40°C to 65°C)

C. Fiber cables shall be shipped on reels in lengths as specified with a minimum overage of 10%:

D. The cable shall be wound on the reel so that unwinding can be done without kinking the cable.

E. Two meters of cable at both ends of the cable shall be accessible for testing.
   1. All fiber shall be tested on the reel for continuity and distance compliance before installation.

F. Each reel shall have a permanent label attached showing length, cable identification num- ber, cable size, cable type, attenuation, bandwidth, and date of manufacture.
   1. Labels shall be water resistant and the writing on the labels shall be indelible.

1.13 PROJECT/SITE CONDITIONS

A. Refer to section 270000

1.14 WARRANTY

A. Refer to section 270000

1.15 MAINTENANCE AND SUPPORT

A. Refer to section 270000

PRODUCTS

2.01 ACCEPTABLE FIBER CABLE MANUFACTURERS

A. Product Manufacturer
   1. Corning
   2. No substitution

B. Indoor Plenum OS2 Singlemode Fiber Cables
   1. Corning # 012E88-33131-A3 (12F)
   2. Corning # 024E88-33131-A3 (24F)
   3. Corning # 048E88-33131-A3 (48F)

C. Indoor/outdoor rated OS2 Singlemode Fiber Cables
   1. Corning # 024EWP-T4101DA3 (24F)
   2. Corning # 048EWP-T4101DA3 (48F)

D. Fiber Connectors (LC-UPC)
   1. Corning # 95-200-99 (OS2)

E. Fiber Duplex Patch Cables (Type SM)
   1. Corning # 040402R5120003M (3M, LC to LC Duplex, OS2)

F. Fiber adapter panels
   1. Corning # CCH-CP12-A9 (OS2, 12-port)
   2. Corning # CCH-CP24-A9 (OS2, 24-port)

G. Fiber Termination Shelf (Rack-Mounted)
   1. Corning # CCH-01U (1RU)
   2. Corning # CCH-02U (2RU)
   3. Corning # CCH-03U (3RU)
   4. Corning # CCH-04U (4RU)

H. Fiber Buffer Tube Fan-out Kit
   1. Corning # FAN-BT36-12

2.02 LABELING

A. Refer to section 270000

2.03 FIRESTOPPING

A. Refer to section 270000

2.04 FIBER BACKBONE CABLING

A. Fiber General Requirements

B. Fiber shall be certified to meet all parts of TIA-455 and comply with TIA-492, ANSI/ICEA S-83-596 and ANSI/ICEA S-83-640 and the NEC.

C. Fibers shall have D-LUX coating or approved equivalent to ensure color retention, mini- mize micro bending losses and improve handling. The coating shall be mechanically strip- pable.

D. Cable installed in plenums or air-handling spaces shall meet UL 910 and shall be marked OFNP (optical fiber non-conductive plenum) in accordance with the NEC.
   1. Plenum Fiber rated cable consisting of multiple fibers shall have a Plenum PVC outer jacket.
      a. Each group of fibers shall have a color-coded Low Smoke PVC buffer.
      b. The buffered fibers are organized in subunits of fibers, reinforced with aramid yarn for extra strength and surrounded with a color-coded low smoke tube.

2. Within the premises, all fiber shall be placed in plenum rated innerduct the entire length of the cable for protection. Use manufacturer plenum rated couplings for all connections.

E. Riser cable shall meet UL 1666 and be marked OFNR (optical fiber nonconductive riser) in accordance with the NEC.
1. Non-plenum, riser rated cable consisting of multiple fibers, shall have an orange, Polyvinyl Chloride (PVC) outer jacket.

F. OSP (Outside Plant) Fiber
1. Stranded loose tube dielectric fiber cable shall be utilized for underground conduit, direct buried, or aerial applications.
2. Underground cable, including cable installed in conduits or duct banks, shall contain an additional moisture barrier in the form of a flooding compound.

G. Fiber conductors shall follow standard color code schemes. Fiber numbers and binders shall correspond to the following color codes:
1. Fiber/Binder No. 1 – blue
2. Fiber/Binder No. 2 – orange
3. Fiber/Binder No. 3 – green
4. Fiber/Binder No. 4 – brown
5. Fiber/Binder No. 5 – slate
6. Fiber/Binder No. 6 – white
7. Fiber/Binder No. 7 – red
8. Fiber/Binder No. 8 – black
9. Fiber/Binder No. 9 – yellow
10. Fiber/Binder No. 10 – violet
11. Fiber/Binder No. 11 – rose
12. Fiber/Binder No. 12 – aqua

H. Cable Minimum Bending Radius:
1. During Installation: 20X cable diameter
2. After Installation: 10X cable diameter

I. Operating temperature range: -76°F to 185°F (-60°C to 85°C)

2.05 SINGLEMODE FIBER REQUIREMENTS

A. Fibers shall have dual wavelength capability, transmitting at 1310 and 1550 nm ranges.

B. 8.3 µm core

C. 125 µm ± 1 µm cladding diameter

D. Cladding non-circularity: = 1%

E. Core/cladding concentricity error: = .5 µm

F. Colored fiber diameter: 254 µm ± 7 µm

G. Maximum Attenuation: 1.0 dB/km at 1310 and 1550 nm (inside premises) and 0.4 dB/km
1. at 1310 and 1550 nm (OSP)

H. Minimum Bandwidth: 20 GHz

I. The mechanical and environmental specifications for OSP fiber cable shall be in accord- ance with ANSI/ICEA S-87-640. OSP fiber cables shall be of a water-block construction and meet the requirements for compound flow and water penetration as established by ANSI/ICEA S-87-640. Outdoor cable shall have minimum pull strength of 2670 N (600 lbf).

2.06 FIBER PATCH CABLES

A. Verify exact quantities and lengths with OWNER prior to purchase

B. Provide the appropriately-rated (matched to the installed cable plant) Modular Patch Cords for the appropriate location and equipment.

C. Singlemode patch cables shall be a stepped-index 8.3 µm core with a 125 µm cladding.

D. Duplex LC connectors shall meet the following specifications:

E. Made and warranted by the manufacturer of the cabling system installed in this project and shall meet or exceed patch cord specifications as outlined in TIA standards.

F. Patch cords shall be in original packaging when presented to the OWNER.

G. Aramid yarn and a jacket of flame-retardant PVC shall cover the fiber cladding.

H. Singlemode patch cable additional requirements:
   1. Return Loss: -50 dB maximum
   2. Mated Connector Loss: $\mu = 0.35$ dB, $\sigma = 0.2$ dB
   3. Connection Repeatability: 0.20 dB maximum changes per 200 re-connects.

I. The Singlemode connector (visible portion) and adapter/outlet shall be identified by the color blue.

2.07 LABELING

A. Refer to Section 270553. PART 3 EXECUTION

2.08 EXAMINATION

A. Refer to Section 270000

B. Verify the following before proceeding:
   1. Conduits, cable trays and pull boxes are properly installed following section 270528
   2. Backboards in communications rooms are properly installed following section 271100
   3. Grounding system is properly installed and tested following section 270526
   4. Liquid-carrying pipes are not installed in or above voice and data system communications rooms.
      a. Do not proceed with installation in affected areas until removed.

2.09 PREPARATION

A. Refer to section 270000

2.10 FIBER INSTALLATION

A. Fiber Cable Installation

B. Fiber cable shall be installed in innerduct from near end termination point to far end ter- mination point.
   1. Only UL-approved plenum-rated innerduct shall be installed in all plenum areas.
   2. Metallic conduit may be used in lieu of innerduct in plenum-rated ceilings if it is bonded and grounded correctly.

C. Only technicians certified by the product manufacturer shall perform terminations.
   1. Terminations shall be made in a controlled environment.
   2. Cables may be assembled off-site, although testing must be completed with the ca- ble in its final installed condition.
   3. Test optical fiber on the reel for distance and continuity verification before installa- tion.

D. At each location where fiber cable is exposed to human intrusion, it shall be marked with warning tags.
   1. These tags shall be yellow or orange in color, and shall contain the warning "CAUTION FIBER OPTIC CABLE".
   2. The text shall be permanent, black, block characters, and at least 0’-.1875” high.
   3. A warning tag shall be permanently affixed to each exposed cable or bundle of ca- bles, at intervals of not less than 5’-0”.

4. Any section of exposed cable that is less than 5’-0” in length shall have at least one warning tag affixed to it.

2.11 FIBER DISTRIBUTION CENTER

A. Contractor shall provide sufficient spare adapter plates to fill the appropriate-sized FDC.

2.12 FIBER TERMINATION AND SPLICING

A. Interconnect Units and Distribution Shelves

B. Modular in design and used in fiber interconnection, cross-connection, and splicing applications

C. 1’-7” (19”) rack-mountable

D. Accept 12-strand, 24-strand, 48-strand or 72-strand terminations

E. OWNER approved industry standard connector

2.13 SPLICING AND CLOSURES

A. Fiber splice modules shall be utilized for all OSP terminations.

B. The link shall consist of:
   1. Fiber cable
   2. Splice
   3. Splice tray holder/closure
   4. Fiber panel/coupler
   5. Pre-manufactured fiber pigtail with pre-polished fiber connector
   6. Fiber jumper to connect the pigtail-coupled link to the appropriate electronic switch

2.14 FIBER FUSION SPLICE

A. Fusion splices shall be mounted in protective trays within the closure.

B. Fusion splices shall not exceed a maximum optical attenuation of 0.3 dB when measured in accordance with ANSI/TIA-455-34, Method a (factory testing) or ANSI/TIA-455-59 (field testing).
   1. Fiber splices shall have a minimum return loss of 26 dB for Singlemode
      a. Minimum Singlemode return loss for broadband analog video (CATV) applica- tions is 55 dB.

2.15 INSTALLATION REQUIREMENTS

A. All installation shall be done in conformance with ANSI/TIA-568-B standards, BICSI methods, and industry standard installation guidelines.

B. The Contractor shall ensure that the maximum pulling tensions of the specified distribu- tion cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities.

C. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation.

D. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.

E. The Contractor shall provide service loops for cables terminating in the communications rooms.

F. A 20’-0” service loop shall be provided at each end and secured in a neat and standards-compliant manner above the equipment racks or cable trays unless specified otherwise.

G. This allows for future changes or expansion without installing new cables.

2.16 DOCUMENTATION

A. All cable inventory data documentation shall be submitted in format coordinated with and approved by OWNER so that data can be incorporated into existing databases.

B. Documentation shall include cable identification number, source and destination, type of cable, length of cable and number of pairs or fibers.

C. Complete cross connect documentation is required. It shall include detailed documenta- tion of each pair of all copper backbone cable and strand of fiber.

2.17 FIELD QUALITY CONTROL

A. Refer to section 270000

2.18 FIBER POST-INSTALLATION TESTING

A. Provide all labor, materials, tools, field-test instruments and equipment required for the complete and proper test measurements of the installed fiber cabling.

B. Contractor shall have successfully attended a fiber testing training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof.

C. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing.

D. Any testing performed on incomplete systems shall be redone on completion of the work.

E. Dust caps shall be placed on fiber endfaces or adapters for each optical fiber link after all testing is complete on the fiber link.

2.19 PRE-TEST SUBMITTALS

A. Manufacturers catalog sheets and specifications for the fiber cable field-test instruments including
   1. OLTS (Optical Loss Test Set)
   2. OTDR (Optical Time Domain Reflectometer)
   3. End-face inspection capture device

B. A schedule (list) of all fiber cables to be tested

C. Fiber testing training program certificate

D. Sample test reports

2.20 FIBER TESTING STANDARDS

A. The Contractor shall meet or exceed the following standards and guidelines:
   1. ANSI/TIA-568-C.0 Optical Fiber Transmission/Test Requirements, and Annex E: Optical Fiber Field Test Guidelines (Tier 2)
      a. Tier 2 testing is a higher level of testing that provides qualitative measures of the installed condition and performance of the cabling system
   2. ANSI/TIA-568-B.3 Optical Fiber Cabling Components Standard
   3. TIA/TSB-140 Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems

B. Singlemode requirements
   1. ANSI/TIA-526-7, Method A.1: Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant-OFSTP-7

C. The cable installers shall have a copy of these references in their possession and be familiar with the contents

D. In order to conform to the overall project event schedule, the contractor shall survey and coordinate the optical fiber testing with other applicable trades.

E. In addition to the test regiment detailed in this document, the contractor shall notify the OWNER of any additional tests that are deemed necessary to guarantee a fully functional system.

F. The contractor shall carry out and record any additional measurement results at no addi- tional charge.

G. The contractor shall provide all test measurement results two (2) weeks prior to substantial completion in spreadsheet format and native file format from the test instrument.

H. Software shall also be provided to view the native results.

I. All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.

J. A visible fault locator (VFL) normally uses a Class 2 or 3 light source and should not be directly viewed.

K. Safe usage of the tool requires indirect viewing of the light source by pointing the end of the fiber at an adjacent surface (or introducing another surface in front of a fixed mounted connector) until the presence of light is determined.

2.21 LINK ATTENUATION MEASUREMENT AND ALLOWANCE CALCULATION

A. The measured link attenuation shall be less than the link attenuation allowance. The link attenuation allowance is calculated as:
   1. Link Attenuation Allowance (dB) = Cable Attenuation Allowance (dB) + Connector Insertion Loss Allowance (dB) + Splice Insertion Loss Allowance (dB)
      a. Connector Insertion Loss Allowance (dB) = Number of Connector Pairs X 0.4dB
      b. Splice Insertion Loss Allowance (dB) = Number of Splices X 0.15dB
      c. Cable Attenuation Allowance (dB) = Maximum Cable Attenuation Coefficient (dB/km) X Length (km)

2.22 FIBER TESTING REQUIREMENTS

A. All installed fiber links shall be field-tested and pass the following tests:
   1. OLTS (Optical Loss Test Set) length and dual wavelength attenuation
   2. OTDR (Optical Time Domain Reflectometer) traces and event tables
   3. Image captures of connector end-faces

B. OLTS (Optical Loss Test Set)
   1. The length and attenuation of each installed fiber link shall be measured and documented.
   2. System loss measurements requirements:
      a. 1310 and 1550 nanometers for Singlemode
   3. Reflective events (connections) shall not exceed 0.75 dB.
   4. Non-reflective events (splices) shall not exceed 0.3 dB.
   5. The acceptable link attenuation for Multi-mode horizontal fiber is based on the max- imum distance of 295’-0”.
   6. A horizontal link in a network with a consolidation point may be tested using a fixed upper limit for attenuation of 2.75 dB.
   7. Optical sources shall be turned on for a minimum of 5 minutes prior to referencing.
   8. Fiber links shall be measured and reported for attenuation in each direction and attenuation bi-directionally (averaged in both directions)
   9. Polarity shall be verified for duplex connector systems
   10. Mandrels
      a. Mandrels shall be used when testing attenuation of Multi-mode fiber cabling
      b. Where mandrels are used, secure the mandrel to the light source by some means such as a cable tie or tape.
      c. Care should be taken to ensure that the fiber jacket is not deformed or damaged when using a cable tie or tape.
      d. The light source shall be referenced to the meter a minimum of twice daily (i.e., in the morning and noon).

C. OTDR (Optical Time Domain Reflectometer)

1. An OTDR trace shall be taken of each fiber link in one direction to ensure uniformity of cable attenuation and connector insertion loss
2. Testing shall consist of a bi-directional end to end OTDR trace performed per TIA 455-61
3. Individual connector, splice and fiber insertion loss shall be evaluated using the OTDR trace.
4. Fibers shall be inspected at 250X for Multi-mode and 400X for Singlemode

D. End-face Image Capture
   a. 1) An image of each fiber optic connector end-face shall be taken, recorded and provided as part of the records.

E. Maximum Attenuation
   1. Singlemode ISP (inside) 1.0 dB/km at 1310 nm and 1550 nm
   2. Singlemode OSP (outside) 0.5 dB/km at 1310 nm and 1550 nm

F. Test Cords (Jumpers)
   1. Testing of the cabling shall be performed using high-quality test cords of the same fiber type and core size as the cabling under test. Use a single patch cord reference for fiber testing.
      a. OLTS test cords shall be between 3’-3” (1m) and 16’-4” (5m).
      b. OTDR testing shall be approximately 328’-0” (100m) for the launch cable and at least 82’-0” (25m) for the receive cable. . OTDR testing shall be Bidirectional with Pigtails installed.
   2. The test jumper, the adapters, and fiber under test shall be cleaned immediately prior to each fiber being tested.
      a. After cleaning, cleaning solutions shall be given sufficient time to evaporate (approximately 30 seconds) prior to the mating of fiber test jumper to the fiber under test.

G. Test Failure
   1. Any fiber link that fails these requirements shall be diagnosed and corrected.
   2. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link meets performance requirements

H. Acceptable Testers
   1. Fluke DTX CableAnalyzer
   2. OWNER Approved equivalent

I. The OWNER or the OWNER’s representative shall be invited to witness, review or both witness and review field-testing.

J. The OWNER or the OWNER’s representative shall be notified of the testing start date, five (5) business days before testing commences.

K. The OWNER or the OWNER’s representative will select a random sample of 5% of the installed links and test that sample.
   1. The measured results obtained from the random sample shall be compared to the data provided by the contractor.
   2. If more than 2% of the sample results differ in terms of the pass/fail determination, the contractor under supervision of the OWNER or OWNER’s representative shall repeat 100% of the testing at no cost to the OWNER.

2.23 TEST RESULTS

A. The detailed test results documentation data is to be provided in an electronic database for each tested fiber strand and shall contain the following information:
   1. Identification of the customer site as specified by the end-user
   2. Name of the test limit selected to execute the stored test results
   3. Name of the personnel performing the test

4. Date and time the test results were saved
5. The manufacturer, model and serial number of the test instrument.
6. The version of the test software and the version of the test limit database held within the test instrument.
7. Fiber identification number
8. Length for each optical fiber
9. Index of refraction used for length calculation when using a length capable OLTS.
10. Test results to include OLTS attenuation link and channel measurements at the ap- propriate wavelength(s) and the margin (difference between the measured attenua- tion and the test limit value).
11. Test results to include OTDR link and channel traces and event tables at the appro- priate wavelength(s).
12. Length for each optical fiber as calculated by the OTDR
13. Overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measure- ments
14. Circuit IDs reported by the test instrument should match the specified label ID

2.24 CLEANING

A. Refer to section 270000

2.25 LABELING

A. Refer to Section 270553

2.26 GROUNDING AND BONDING

A. Refer to Section 270526.

2.27 ACCEPTANCE

A. Refer to Section 270000.

END OF SECTION

SECTION 271500
COMMUNICATIONS HORIZONTAL CABLING

GENERAL

1.01 SUMMARY

A. This section of the horizontal cabling portion of a structured cabling system includes:
   1. UTP Copper cabling
   2. Termination and patch cables

B. Provide all horizontal cabling, terminating hardware, adapters, and cross-connecting hardware necessary to interconnect all system equipment including equipment located in communications rooms.

1.02 RELATED SECTIONS

A. Section 270526 Grounding and Bonding for Communications Systems

B. Section 270528 Interior Pathways for Communications Systems

C. Section 270543 Exterior Pathway for Communications Systems

D. Section 270553 Identification for Communications Systems

E. Section 271100 Communications Equipment Room Fittings

F. Section 271300 Communications Backbone Cabling

G. Section 272100 Data Communication Network Equipment

1.03 REFERENCES

A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.

B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.

1.04 CONFLICTS

A. Refer to section 270000

1.05 CODES AND STANDARDS

A. Refer to section 270000

1.06 SUBMITTALS

A. Refer to sections 270000

1.07 QUALITY ASSURANCE

A. Refer to sections 270000

B. In addition to the Contractor Qualifications requirements of section 270000, the Con- tractor shall be a CommScope Uniprise certified installer (authorized Uniprise reseller) and capable of providing a CommScope Uniprise System warranty. Provide satisfac- tory evidence of certification in the form of a current letter or certificate from the man- ufacturer as part of the bid submission and pre-construction submittals.

C. Monitor and maintain quality control over manufacturers, suppliers, subcontractors, work force, site conditions, products, and services to ensure Work is of specified quality.

D. Workmanship: Install material and equipment in neat and workmanlike manner, in accordance with NEC Section 800-6. Specified requirements represent minimum acceptable quality for Work. Comply with industry standards except when more stringent requirements are specified herein, and tolerances indicate higher standards or more precise workmanship.

E. All communications work shall be performed under the direct on-site supervision of a Building Industry Consulting Service International, Inc. (BICSI) Certified Registered Communications Distribution Designer (RCDD). Include resumes and RCDD registration in Product Data Submittal to the A&E team and County IT representative for review and approval. Paperwork must be approved by the A&E team and County IT representative in writing prior to construction. The RCDD must be at the job site during construction. The RCDD shall be present during all cable testing, pulling and termination procedures.

F. Provide all materials, equipment, and installation in compliance with the latest applicable standards from ANSI, FCC, ASTM, TIA, IEEE, NEC, NFPA, NEMA, REA, and UL.

G. Install products only by qualified technicians certified by manufacturers.

H. Provide all electronic equipment with the UL label when applicable.

I. Comply in every way with the requirements of local laws and ordinances, the National Board of Fire Underwriters, and the National Electrical Code. Anything in the plans or specifications that does not strictly comply with the above laws, ordinances, and rules must be referred to the attention of the Engineer for a decision before proceeding. No change in the IT plans and specifications shall be made without full consent in writing by OWNER.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Refer to sections 270000

1.09 PROJECT/SITE CONDITIONS

A. Refer to section 270000

1.10 WARRANTY

A. Refer to section 270000

1.11 MAINTENANCE AND SUPPORT

A. Refer to section 270000

PRODUCTS

2.01 GENERAL

A. REFERENCE STANDARDS
   1. ISO 9001 - Quality Management Systems — Requirements; 2026.
   2. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; 2024e.

B. CommScope is the standard for horizontal cabling system installation.

C. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to CommScope and other manufacturers as referenced in this document.

D. The project shall be registered for a 25-year warranty and test data submitted for acceptance.

E. Horizontal Cable and Termination Components specified are to function as a System.

F. All horizontal cabling components shall be from the sane manufacturer to obtain the sys- tem warranty.

2.02 HORIZONTAL CABLE TYPES INCLUDE:

A. 4-pair Copper Unshielded Twisted Pair (UTP) CAT6A

2.03 UTP CABLING COLOR CODE:

A. See table below for the color standard by applications

Application	Horizontal Cable Color	RJ45 Jack Color	Patch Cord Color
Data	Blue	Blue	Blue

WiFi	Green	Green	Green
Security	Purple	Purple	Purple
Fire Alarm	Red	Red	Red
POTS Voice	Orange	Orange	Orange
BAS	White	White	White
Audio-Video	Gray	Gray	Gray

2.04 4-PAIR UTP HORIZONTAL COPPER CABLE

A. The 4 pair UTP cable installed inside the buildings shall be Underwriter Laboratories (UL) listed type CMP, unless cables are routed through underground or unconditioned spaces where OSP cables shall be used.

2.05 PLENUM RATED HORIZONTAL UTP CAT6A CABLE PRODUCTS:

A. CommScope # CS44P

2.06 OUTSIDE PLANT (OSP)–RATED CATEGORY 6A CABLE PRODUCTS:

A. CommScope # CS44P-IO (black, outdoor and plenum rated, but not for direct burial installations)

B. Provide surge protector that can pass POE for each OSP cable at both ends.

2.07 TELECOMMUNICATIONS OUTLETS FACEPLATE

A. Manufacturers:
   1. CommScope

B. Faceplate housing shall be one piece, flush mount style that fits standard NEMA openings.

C. Faceplates shall have two separate labeling areas.

D. Label areas shall be covered with a clear plastic insert.

E. Unused ports shall have blank inserts installed.

F. Plastic, color white

2.08 FACEPLATE PRODUCTS

A. CommScope # M12L-262 (2-port)

B. CommScope # M14L-262 (4-port)

C. CommScope # M20AP-262 (blank dust cover)

2.09 SURFACE MOUNT OUTLETS

A. Surface mounted plenum rated biscuit block with plenum rated modular jack or connector.

B. Made of High Impact thermoplastic.

C. Surface mounted outlet shall be used when data outlet is located in an equipment en- closure box, or above an accessible ceiling . or inside a recessed outlet box with sur- face mounted device (camera, WiFi Access Point, etc.).

2.10 SURFACE MOUNT OUTLET PRODUCTS

A. CommScope # SMB-1P-262 (1-port)

B. CommScope # SMB-2P-262 (2-port)

2.11 MODULAR UTP CONNECTORS

A. Modular jacks shall be RJ45, 8 pin-8onductor, non-keyed, CAT6A rated.

B. Insulation displacement type contact.

2.12 RJ-45 JACK PRODUCTS

A. CommScope # UNJ-10G

2.13 DATA PATCH CABLES

A. All data patch cables shall be manufacturer pre-assembled.

B. Provide two (2) patch cables per horizontal data cable installed and match the cable type and color of the horizontal cables.

2.14 PATCH CORD LENGTHS

A. 50% 10-ft long, 25% 5-ft long and 25% 7-ft long for fire station projects.

B. 25% 5-ft long and 75% 7-ft long for all other projects.

2.15 DATA PATCH CABLE PRODUCTS

A. CommScope # MiNo6A

2.16 DATA PATCH PANELS

A. Products
   1. CommScope # CPP-UDDM-M-2U-48 (48-port, 2U)
   2. CommScope # CPP-UDDM-M-1U-24 (24-port, 1U)

2.17 POE ETHERNET SURGE PROTECTION DEVICE (SPD)

A. Roof or Tower Mount

B. Unit shall pass POE+

C. Use in the field for pole and roof mount Access Points. The device shall be rated for out- door use. Bond to approved building ground.

D. Ditek# DTK-MRJPOEX or approved equal.

E. Install in IDF/MDF

F. Unit shall pass POE+

G. Use in MDF/IDF closet. Bond to PBB/SBB.

H. Rackmount: DTK-RM##NETS (##: 12, 16, or 24), if 4 or more are required in MDF/IDF.

EXECUTION

3.01 EXAMINATION

A. Refer to Section 270000

3.02 PREPARATION

A. Refer to section 270000

B. The Contractor shall check pathways, raceways, and other elements for compliance with space allocations, installation tolerances, debris, hazards to cable installation, and other con- ditions affecting installation prior to installation.

C. All conduits shall be provided with bushings before cable pulling to start

3.03 INSTALLATION REQUIREMENTS

A. Refer to section 270000

B. All installation shall be done in conformance with ANSI/TIA-568 standards, BICSI methods, industry standards and manufacturer's installation guidelines.

C. The Contractor shall ensure that the maximum pulling tensions of the specified distribu- tion cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities.

D. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation.

E. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.

F. Install cable using techniques, practices, and methods that are consistent with specified data cabling and the installed components and that ensure specified performance levels of completed and linked signal paths, end to end.

G. Pull cables in smooth and regular motions using methods that prevent cable kinking.

H. Pull cables simultaneously if more than one is being installed in the same raceway/path- way.

I. If necessary, use approved cable pulling lubricant

J. Use fish tape, cable, rope, basket weave wire/cable grips, and other tools that will ensure no damage to the media or raceway.

K. Install open cabling parallel and perpendicular to surfaces or structural members follow- ing surface contours where possible.

L. Do not bend cable greater than a bend radius of 0'-1".

M. Provide a 10'-0" service loop at the communications room and shall provide a 3'-0" service loop above the access ceiling or cable trays unless specified otherwise.

N. All service loops shall be a minimum of 1'-6" (18") in diameter and be accessible for maintenance.

O. Coordinate loop placement and orientation with the technology consultant.

P. This allows for future changes or expansion without installing new cables.

Q. Install cables in continuous "home run" lengths from work station outlet to specified patch panel.

R. No intermediate punch-down blocks or splices may be installed or utilized between the communications rooms and the workstation outlet without written OWNER permission.

S. All cable must be handled with care during installation so as not to change performance specifications.

T. Factory twists of each individual pair must be maintained up to the connection points at both ends of the cable.

U. There shall never be more than 0'-½" of unsheathed cable at either the wiring closet or the workstation termination locations.

V. All cabling and associated hardware shall be placed so as to make efficient use of available space.

W. All cabling and associated hardware shall be placed so as not to impair equipment's effi- cient use of their full capacity.

X. All horizontal UTP data cable runs shall be within the permanent link distance limit of 295-ft. Contractor shall verify the cable run distance before installation and notify A&E team and OWNER representative immediately if any of the data cable runs might exceed the distance limit. All exceptions shall be reviewed and approved by OWNER representative. The contractor shall be responsible for all mitigation required to bring the cable runs within the distance limit or OWNER approved alternative solutions.

3.04 CABLING METHODS

A. The Contractor shall provide cabling in accessible spaces, cable tray, (surface and/or enclosed raceway), conduits, and/or J-Hook cable support system.

B. Within consoles, racks, cabinets, desks, and counters, in accessible ceilings spaces and in gypsum board partitions where open cable method may be used.

C. Use UL or ETL listed plenum rated cable in all spaces.

D. Provide all necessary installation materials, hardware, tools and equipment to perform insulation displacement type terminations at all data outlets, patch panels, and voice termination materials.

E. Conceal raceway and cabling except in unfinished spaces as is practical.

3.05 EXPOSED CABLE

A. All station cabling shall be installed inside walls or ceiling spaces whenever possible.

B. All cables outside walls below finish ceiling shall be installed in approved communication raceway. Exposed station cable will only be run where indicated on the drawings and will only be allowed when no other options exist.
   1. OWNER must approve all exceptions.

C. The Contractor shall utilize conduits/cable tray as indicated on the drawings.

D. All cabling placed above drop ceilings must be supported by cable tray, J-hooks, caddy bags or conduit.

E. The Contractor shall permanently affix cable supports to the building structure or sub- strates and provide attachment hardware and anchors designed for the structure to which attached and are suitably sized to sustain the weight of the cables to be supported.
   1. Attaching cable to pipes or other mechanical items is not permitted.
   2. Cabling shall not be attached to ceiling grid wires.

F. Multiple cables are to be dressed every 5’-0” to 7’-0”.
   1. Maximum cable sag between cable hooks is 3”-6”.

G. The Contractor shall route data and voice cables separately in a neat and orderly fashion.

H. No cable ties or wraps shall be used to secure the cables in the runway outside of the communications rooms. Cable ties shall be rated for the environment.

I. Keep all items protected before and after installation with dust and moisture proof barrier materials/envelopes.

J. If wiring is terminated on patch panels, data, voice jacks prior to painting, carpet installation, and general finish clean up, these jacks shall be placed in a protective envelope to ensure dust, debris, moisture, and other foreign material do not settle onto jacks’ contacts.

K. Envelope will be removed on final trim out after other trades have completed their finish work.

L. It shall be the Contractor’s responsibility to ensure the integrity of these protective measures throughout the life/installation of the project.
   1. Cable bundles brought into the communications rooms shall be routed and dressed in such a manner that prior to termination the cables are not subject to damage and misuse such as installers walking on the bundles that are on the floor.
   2. Cable pulling force shall not exceed 25 lbs of pulling tension or cable manufacturer’s recommended pulling tensions.
   3. Do not leave cables on the floor unprotected or cable bundles hanging from the ceilings. Coil them up in a temporary manner and protect them from damage.

M. Communications room cables shall be combed and dressed in a manner as to prevent twists, “braiding” and crossed cables in the cable bundle from the communication room entrance to the termination point at the rear of the patch panel.

N. Behind the patch panel, the cable bundle shall be attached to the rear cable support bar, and shall drop out each cable in a neat, cascading manner to prevent crossed and/or interwoven cables to each patch panel port termination point.
   1. Use Velcro wraps instead of cables ties for all bundling in the communications rooms.
   2. Plastic/nylon tie-wraps are not allowed to permanently secure cables inside the communications room.

3.06 CABLING SEPARATION

A. Comply with TIA rules for separating unshielded copper communication and data-processing equipment cables from potential EMI sources, including electrical power lines and equipment.

B. Maintain a minimum spacing of 1’-6” (18”) from electrical feeders and/or branch circuit wiring including, but not limited to, light fixtures, sources of heat and EMI sources.

C. Maintain a minimum spacing of 1’-0” from auxiliary systems cabling.

D. Maintain a 1’-0” separation where cables must pass perpendicularly to electrical, plumbing, or other wiring, conduit, or piping systems.

E. Use non-conduit bushings, if necessary to maintain separation, which allow for the addition of a reasonable number of cables in the future.

F. Maintain communications pathways away from electrical apparatus such as motor driven equipment and transformers, minimum separation distance of 10’-0” is recommended.

3.07 CABLING TERMINATION

A. Terminate cables in consistent consecutive order.

B. Terminate cables onto 8P8C modular patch panels without damaging twisted pairs or jacket.

C. Arrange cables on patch panels and voice termination hardware in ascending order of room numbers and outlet numbers within rooms.

D. Provide a 10’-0” service loop for horizontal cables at each rack in communications rooms.

E. Cables shall follow the longest route along perimeter of the room inside MDF?IDF rooms to reach the destination patch panels. 10’ service loop is provided in this manner to avoid big service loop bundles

F. For MDF/IDF rooms with cable tray around the perimeter of the room, Locate service loop at ceiling deck or on wall in a neatly coiled bundle.

G. Provide a 3’ service loop for horizontal cables at work area outlets, and locate the service loop above or below data/voice outlet where vertical cable run transitions to horizontal run.

H. Maintain twists in cable pairs to within 0’-½” of termination.

3.08 BUILDING SYSTEMS CABLING (BAS, FA, ELEVATOR LINE, ETC)

A. Coordinate exact placement and connectivity requirements with applicable trade prior to installation.

B. Group all building systems cables in one group.

C. Clearly label cable number and function, in the last positions on the horizontal cabling blocks in each communications room.

D. Limit cable-bending radius to 20X the cable diameter during installation, and 15X the cable diameter after installation.

E. Start numbering at the left of the main door to the room and continue in a clockwise direction around the room.

F. The cables within the room will be terminated starting with the cables located to the left of the main door to the room and continuing around the room in a clockwise direction.

3.09 TERMINATION HARDWARE

A. Station Hardware

B. Flush mount jacks shall be mounted in a faceplate with a back box.

C. Outlets shall not be mounted on temporary, movable, or removable surfaces, doors, or access hatches without prior OWNER approval.

D. 8P8C Jack Pin Assignments for work area outlets shall match the T-568B wiring scheme.

3.10 PATCH PANELS

A. Copper cables shall be terminated in 110 style eight position/eight conductor (8P8C) patch panels.

B. All cable terminations shall match the T-568B wiring scheme.

3.11 WORK AREA OUTLET

A. 8P8C non-keyed modular outlets for applications up to 10 Gbps and ANSI/TIA-568 com- pliant for the specified transmission requirements

3.12 WORK AREA OUTLET FACEPLATES:

A. Furnish and install blank dust cover in all unused ports.

B. Furnish and install blank plate to cover in all unused outlet boxes.

3.13 SPECIAL CIRCUITS

A. The Contractor shall coordinate with the OWNER on the cable termination plan for special circuits, including cables to wireless access point locations, security, elevators, fire alarms, etc.. Ter- minate Data cables to surface mounted outlet boxes where outlets are located inside the equipment enclosure or devices will be mounted directly above the outlet boxes.

3.14 WIRELESS ACCESS POINTS

A. Enclosures shall be NEMA rated for the environment to which they are exposed.

B. 30’-0” of cable slack shall be coiled and hung on a “J”-hook at the enclosure location.

3.15 IDENTIFICATION AND LABELING

A. Refer to section 270553 for more information.

B. Labeling system shall consist of a hand-held portable printer and labels appropriate to the application. Handwritten labels are not acceptable.

C. Labelling scheme shall meet OWNER’s IT cabling standard and industry standards and best prac- tices. Submit the labeling scheme for approval before work to start.

D. Fiber termination hardware (designation strip) shall have a 0’-¾” x 0’-¼” thermal transfer print- able label with a permanent acrylic adhesive

E. All labels shall be permanent and shall not fade, peel, or deteriorate due to environment or time.

F. The Contractor shall provide a copy of the finalized plan in writing to the OWNER representative and IT Consultant for review and authorization to proceed.

G. Coordinate with OWNER for specifications on labeling of all hardware, cabling, and related equipment prior to installation.

3.16 LABELING REQUIREMENTS:

A. Label cable terminations on designation strips

B. Label all cables at each terminating point.

C. Label each port of the work area outlet.

D. Cable identification numbers shall not be duplicated.

E. Label patch panels in the communications rooms to match those on the corresponding voice and data outlets.
   1. The font shall be at least 0’-1/8” in height.

F. Where a wireless access point is installed above an acoustical ceiling, label the ceiling grid frame below the access point, displaying the data port number and, if applicable, the access point identification number. Coordinate labeling of grid with OWNER and Architect prior to application of labels.

G. Label each distribution rack, block and other terminating equipment unit and field within that unit within 0’-4” from the block or patch panel termination. Keep labels in a neat and orderly lineup.

H. Label each connector and each discrete unit of cable-terminating and connecting hard- ware within connector fields, in wiring closets and equipment rooms.
   1. Where similar jacks and plugs are used for both communication and data-processing equipment, use a different color for jacks and plugs of each service.

I. Post the cable schedule in a prominent location in each wiring closet and equipment room. List incoming and outgoing cables and their designations, origins, and destinations.

3.17 UNIQUE IDENTIFIERS

A. Segregation and position on equipment rack

B. Port color-coding

C. Unique labeling

3.18 DOCUMENTATION

A. Provide electronic copy of final comprehensive schedules for project in software and for- mat selected by OWNER.
   1. All labels shall correspond to as-built drawings and to final test reports.

B. All cable inventory data documentation shall be submitted in format coordinated with and approved by OWNER so that data can be incorporated into existing databases.

C. Documentation shall include cable identification number, source and destination, type of cable, length of cable and number of pairs or fibers.

D. Complete cross connect documentation is required.

3.19 FIELD QUALITY CONTROL

A. Refer to section 270000

3.20 POST-INSTALLATION TESTING

A. Contractor shall test each pair or strand of every cable prior to acceptance. (100% PASS)

B. Contractor shall submit acceptance documentation as defined below. No cabling installation is considered complete until test results have been completed, submitted and approved.

3.21 STANDARDS COMPLIANCE AND TEST REQUIREMENTS:

A. Cabling shall meet ANSI/TIA-568.2 Category 6A Horizontal cabling requirements.

B. Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT, and PSELFEXT data that indicate the worst case result, the frequency at which it occurs, the limit at that point, and the margin.

C. These tests shall be performed in a swept frequency manner from 1 MHz to the highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements.

D. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards.

E. Length, propagation delay, and delay skew relative to the relevant limit.
   1. Length, propagation delay, and delay skew shall be tested relative to the relevant limit.
   2. Test shall also include mutual capacitance and characteristic impedance.
      a. Any individual test that fails the relevant performance specification shall be marked as a ‘FAIL”.

3.22 CABLE TEST DOCUMENTATION:

A. Cable test documentation shall be submitted in hard copy and electronic formats.
   1. If proprietary software is used, disk or CD shall contain any necessary software ap- plication required to view test results.
   2. Electronic reports shall be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report.

3. Certificate shall reference traceable circuit numbers that match the electronic record.

B. Each test record shall contain the cable ID as follows:
   1. “MEDIA TYPE – TR Room ID – Cable #”, e.g. CAT6A-201-002.

C. Test results saved within the field-test instrument shall be transferred into an accessible database utility that allows for the maintenance, inspection and archiving of the test rec- ords.
   1. These test records shall be uploaded to the PC unaltered, i.e., “as saved in the field- test instrument”.
   2. The file format, CSV (comma separated value), does not provide adequate protec- tion of these records and shall not be used.

D. Test reports shall include the following information for each cabling element:
   1. Wire map results that indicate that 100% of the cabling has been tested for shorts, opens, miss-wires, splits, polarity reversals, transpositions, presence of AC voltage and end-to-end connectivity.
   2. Length, propagation delay, and delay skew relative to the relevant limit. Any individ- ual test that fails the relevant performance specification shall be marked as a FAIL.
   3. Cable manufacturer, cable model number/type, and NVP
   4. Tester make & model, serial number, hardware version, and software version.
   5. Cable ID and project name
   6. Auto-test specification used
   7. Overall pass/fail indication
   8. Date of test

3.23 CABLE TEST EQUIPMENT

A. Contractor shall supply all of the required test equipment used to conduct acceptance tests.

B. Test equipment used under this contract shall be from manufacturers that have a mini- mum of 5 years experience in producing field test equipment. Manufacturers shall be ISO 9001 certified.

C. Testing equipment shall be UL-verified to meet Level V accuracy.
   1. The cable installers shall have a copy of this reference in their possession and be familiar with the contents.

D. Testing equipment shall be within the calibration period recommended by the manufac- turer.

E. Testing equipment shall have the latest software and firmware installed.

F. Testing equipment of a given type shall be from the same manufacturer, and have com- patible electronic results output.

G. Test adapter cables shall be approved by the manufacturer of the test equipment.
   1. Adapter cables from other sources are not acceptable.
   2. Adapter cables must be replaced after 1000 tests to ensure accuracy.

H. Test equipment must have a dynamic range of at least 100 dB to minimize measurement uncertainty.

I. Test equipment must be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.

J. Test equipment must include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.

K. Test equipment must be capable of running individual NEXT, return loss, etc measure- ments in addition to auto tests. Individual tests increase productivity when diagnosing faults.

L. Test equipment must include a library of cable types, sorted by major manufacturer.

M. Test equipment must be able to internally group auto tests and cables in project folders for good records management.

1. Test equipment must store at least 1000 auto tests in internal memory.

N. Test equipment must include DSP technology for support of advanced measurements.

O. Test equipment must make swept frequency measurements in compliance with TIA standards.

P. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector.

Q. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.

R. Acceptable testers:
1. Fluke DTX CableAnalyzer
2. OWNER approved equivalent

3.24 CLEANING

A. Refer to section 270000

3.25 ACCEPTANCE AND CLOSEOUT

A. Refer to section 270000

END OF SECTION

SECTION 272100
DATA COMMUNICATIONS NETWORK EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Subject to the General and Special Conditions, this section shall specify…

B. Section Includes:
   1. Core switch in MDF
   2. Access Switch in IDF
   3. Wireless Access Point (WAP)
   4. Rack UPS
   5. Integrated Service Router

C. The Contractor shall furnish, install and test a complete network system of switches, routers, WAPs, UPS, power supply, if applicable, and all accessories for a complete functioning system.

D. Related Sections:
   1. Div 01
   2. Section 270000 Communications
   3. Section 270526 Grounding and Bonding for Communications Systems
   4. Section 270528 Interior Pathways for Communications Systems
   5. Section 270543 Exterior Pathway for Communications Systems
   6. Section 270553 Identification for Communications Systems
   7. Section 271100 Communications Equipment Room Fittings
   8. Section 271300 Communications Backbone Cabling
   9. Section 271500 Communications Horizontal Cabling

1.02 DEFINITIONS AND ABBREVIATIONS

A. Abbreviations
   1. ANSI American National Standards Institute
   2. ATM Asynchronous Transfer Mode
   3. Gbps Gigabits per second
   4. IEEE Institute of Electrical and Electronic Engineers
   5. ISO International Organization for Standardization
   6. Mbps Megabits Per Second
   7. MIMO Multiple-In and Multiple-Out
      a. Multi-path The possible multiple routes of a single source of RF energy due to reflection, refraction, or diffraction.
      b. NEC National Electrical Code
      c. NEMA National Electrical Manufacturing Association
      d. RF Radio Frequency: Signal generated by a radio transmitter and sent out through an antenna. The frequency of the transmission is described in terms of the number of cycles per second or Hertz (Hz).
      e. SFP Small Form-Factor Pluggable – Hot-pluggable transceiver used for both telecommunication and data communication applications. Comes in both copper and fiber.
      f. SNMP Simple Network Management Protocol
   8. TIA Telecommunications Industry Association
   9. TR Telecommunications Room
   10. UL Underwriter's Laboratories
   11. VoIP Voice over Internet Protocol
   12. WAP Wireless Application Protocol

a. WPA/WPA2 WiFi Protected Access / WiFi Protected Access II – IEEE 802.11i-2004

1.03 REFERENCES

A. Refer to section 270000.

1.04 COORDINATION

A. Refer to General or Special Conditions and section 270000.

B. Coordinate with OWNER for product submittal review/approval, procurement, installation and ac- ceptance punchwalk. All network equipment shall be configured by OWNER. Contractor shall plan to deliver all IT equipment to OWNER and allocate a minimum of two weeks for equipment con- figuration.

1.05 QUALITY ASSURANCE

A. Refer to section 270000.

B. Assure that the "as installed" system is correct and complete per construction documents: including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.

C. Owner/Architect/Engineer retains the right to access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at the expense of the contractor.

D. UL Compliance: Provide products that are UL-classified and labeled.

E. Installer Qualifications
   1. Installer shall have a minimum certification of Cisco CCNA.
   2. Knowledge of NEC standards.
   3. Knowledge of EIA/TIA standards.
   4. Five (5) years experience in the installation of local and wide area network hardware and software including hubs, routers, switchers, terminating and testing.
   5. Five (5) years experience in the installation and configuration of 1000BASE-T, 10GBASE-T, 10GBASE-LR, 10GBASE-SR , FDDI, ISDN, ATM and Token Ring networks.
   6. Five (5) references for projects of equivalent scope, type and complexity of work completed within the last five (5) years. The Contractor shall submit as proof, supporting documents and the names, addresses and telephone numbers of the operating personnel who can be contacted regarding the installation system.
   7. Must be certified by the equipment manufacturers to install and configure the specified products.

F. Install products only by qualified technicians.

G. Provide all electronic equipment with the UL label when applicable.

H. Comply in every way with the requirements of local and City laws and ordinances, the National Board of Fire Underwriters, and the National Electrical Code. Anything in the plans or specifications that does not strictly comply with the above laws, ordinances, and rules must be referred to the attention of the Engineer for a decision before proceeding. No change in the plans or specifications shall be made without full consent in writing of the Engineer.

I. Contractor is responsible to ensure equipment has the correct modules, quantities, and firmware updates for a complete and functional system. If drawings or specifications are not accurate, contractor shall notify owner of discrepancy prior to bid. Owner will not be responsible to pay for any additional equipment that contractor left out to make the system completely functional.

1.06 SUBMITTALS

A. Refer to section 270000.

1.07 LABELING

A. Refer to section 270553.

1.08 WARRANTY

A. Provide in accordance with Division 01 and section 270000.

B. Provide a three (3) year warranty on all active network products and installation.

C. Provide the Owner with on-line telephone support for the network active products and configuration for a period of two (2) years.

D. The Contractor shall bear the burden to replace or repair any such defective products during the three (3) year period at his cost including labor and materials.

PART 2 PRODUCTS

2.01 PRODUCT MANUFACTURER

A. City of Houston has established Cisco as the standard for network switches, routers, and WiFi Access Point device installation, and APC for UPS and PDU installation.

B. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to Cisco, APC and other manufacturers as referenced in this document. However, substitutions for Cisco and APC products are not permitted.

2.02 NETWORK SWITCH

A. Cisco Catalyst C9300-HX
   1. Verify with OWNER about the exact model and components required.

2.03 ROUTER

A. Cisco Catalyst 8200/8300/8500 Series Edge
   1. Verify with OWNER about the exact model and components required.

2.04 WIRELESS ACCESS POINT (WAP)

A. Cisco Wireless CW9176I
   1. Verify with OWNER about the exact model and components required.
   2. Provide mounting brackets.
   3. Provide indoor unit for building interior, outdoor unit for building exterior.

2.05 UPS

A. General requirements
   1. All UPS shall be rack mounted, unless otherwise noted.
   2. All UPS shall have a network management card. Minimum of one of them in each IT room shall have environment monitoring capability.
   3. The UPS provides early-warning fault analysis on batteries and will project battery replacement dates, enabling timely preventive maintenance.

2.06 RACK MOUNT UPS – TYPE 1A

A. APC SMT2200R2X106
   1. Include one (1) network management card for each UPS. Minimum of one (1) in each IT room (MDF/IDF) shall be AP9641, AP9640 for others.
   2. This model is used for wall mounted cabinet or rack with a height of 22RU or less.

2.07 RACK MOUNT UPS – TYPE 1B

A. APC SRT3000RMXLA
   1. Include one (1) network management card for each UPS. Minimum of one (1) in each IT room (MDF/IDF) shall be AP9641, AP9640 for others.
   2. This model shall be provided for all cabinet or rack with a height of 23RU or more.

B. PDU - Type 1A
   1. 1.9KW
   2. Input 120 VAC Nominal, 20 Amp Circuit, NEMA 5-20P
   3. Output; 120 VAC, (12) 5-20R
   4. Triplite RS-1215-20

C. PDU - Type 1B UPS
   1. 2.9KW
   2. Input 120 VAC Nominal, 30 Amp Circuit, NEMA L5-30P
   3. Output; 120 VAC, (24) 5-20
   4. APC SKU AP7532 (or owner approved equal)

D. General Requirements
   1. All UPS and PDUs will be provided and installed by contractors, UON.

PART 3 EXECUTION

3.01 PRODUCT HANDLING

A. The Contractor shall be responsible for any and all loss or damage in the shipment and delivery of all material until transfer of title to the City.

3.02 PREPARATION

A. Heating, ventilation, and air conditioning sensors and control equipment must maintain the room temperature between 64° F and 87° F. The relative humidity must be 20% to 80%.

3.03 INSTALLATION

A. Install components in accordance with contract drawings, manufacturer’s instructions and approved submittal data.

B. System installation and construction methods shall conform to the requirements of the Federal Communications Commission.

C. The Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and adjustments required for a complete and operable system.

D. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

E. The Owner Representative shall perform final configuration of the network equipment. This includes, but is not limited to: VLAN configuration, IP addressing schemas, final port assignments, and trunking/bonding configurations. Installation contractor shall ensure that the proper documentation is provided to assist in the final system configuration.

3.04 HARDWARE INSTALLATION

A. The Contractor shall obtain written permission from the City Engineer before proceeding with any work which requires cutting into or through any part of the building structures such as, but not limited to, girders, beams, concrete, carpeted or tiled floors, partitions or ceilings. The Contractor shall also consult with the City Engineer before cutting into or through any part of the building structures where fireproofing or moisture proofing could be impaired.

B. The Contractor shall take all steps necessary to ensure that all public areas remain clear or are properly marked during installation or maintenance.

C. The Contractor shall develop a detailed network map to be utilized as a road map during the implementation of the LAN. This map shall show all segments, all interconnects between segments and all active network devices. This network map shall not include the individual nodes interconnected to each concentrator, but will have the modules, interfaces, protocols, addresses and other identifying features for each concentrator and other active device.

D. The Contractor shall also develop a Cable Plant interconnectivity chart showing all fiber patch panels and individual identifiers for each fiber associated with the interconnectivity of each network device.

E. Prior to installing Wireless Access Points, conduct and document an RF site survey to determine the maximum operating range between an AP (fixed location) and mobile stations for a specified transmit power level. Survey shall also identify holes of coverage due to multi-path, interference sources, and interference from other wireless installations. Contractor shall make any adjustment as necessary to the location of AP devices to achieve optimum and uniform coverage.

F. The contractor shall place materials only in those locations that have been previously approved. The City Engineer shall approve any other locations, in writing.

3.05 SYSTEM STARTUP

A. The Contractor shall not apply power to the system until after:
   1. System and components have been installed and inspected in accordance with the manufacturer's installation instructions.
   2. A visual inspection of the system components has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
   3. System wiring has been tested and verified as correctly connected as indicated.
   4. All system grounding and transient protection systems have been verified as properly installed and connected, as indicated.
   5. The City Engineer and the IT Representative have approved the installation.

B. Satisfaction of the above requirements shall not relieve the contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of contractor’s deficient work/defective equipment.

3.06 ACCEPTANCE TESTING

A. The contractor shall develop and execute an onsite acceptance-testing program.

B. The plan shall address all requirements identified in this specification and test all contractor supplied cabling and hardware components. The plan shall follow accepted industry testing practices and have a method of independent verification described.

C. Any specified item that does not satisfy the requirements of this specification shall be replaced, upgraded, or added by the contractor as necessary to correct the noted deficiencies. After correction of a noted deficiency, re-testing shall be performed to verify the effectiveness of the corrective action.

3.07 LABELING

A. Refer to section 270553

3.08 GROUNDING AND BONDING

A. Refer to section 270526

3.09 ACCEPTANCE

A. Refer to section 270000

END OF SECTION

SECTION 274116
INTEGRATED AUDIO-VIDEO SYSTEM AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. This document covers the general requirements for the installation of audio-video (AV) systems.

B. Project Overview
   1. Design Consultant to provide project overview here.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections
   1. Div 26
   2. Section 270000 Communications
   3. Section 270526 Grounding and Bonding for Communications Systems
   4. Section 270528 Interior Pathways for Communications Systems
   5. Section 270543 Exterior Pathway for Communications Systems
   6. Section 270553 Identification for Communications Systems
   7. Section 271500 Communications Horizontal Cabling

1.03 CODES AND STANDARDS

A. Perform all work in strict accordance with the requirements and recommendations stated in the codes and standards except when requirements are exceeded by the contract documents.

B. The equipment, materials, and installation shall confirm to the latest version of all applicable codes, standards and regulations of authorities having jurisdiction including the following:
   1. American National Standards Institute (ANSI)
   2. American Society for Testing and Materials (ASTM)
   3. Alliance for Telecommunications Industry Solutions (ATIS)
   4. Federal Communications Commission (FCC)
   5. International Electrotechnical Commission (IEC)
   6. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
   7. International Organization for Standardization (ISO)
   8. International Organization of Standardization/International Electrotechnical Commission (ISO/IEC)
   9. National Cable Television Association (NCTA)
   10. National Electrical Code (NEC)
   11. National Electrical Manufacturers Association (NEMA)
   12. National Fire Protection Association (NFPA)
   13. National Institute Standards and Technology (NIST)
   14. Occupational Safety and Health Administration (OSHA)
   15. Telecommunications Industry Association (TIA)
   16. Comply with terms and conditions of Americans with Disabilities Act, especially regarding provisions for hearing impaired and wheelchair access in control areas.
   17. Execute work in accordance with best AV system installation practices, and applicable state and local codes.
   18. Owner’s Design Guidelines and Construction Standards

1.04 SUBMITTALS

A. General
   1. Refer to Division 1 and section 27 00 00.

2. Submit in quantities, format and timetable as required by General Conditions.

B. Product Submittals
   1. Contractor shall submit catalogue cut-sheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be handwritten and/or highlighted to indicate the exact selection.
   2. Contractor shall identify the applicable specification section reference for each product performance for each component specified for approval prior to purchase and installation.
   3. Minimum number of Sets: four (4) or one (1) electronic copy.
   4. Provide a list of equipment (model and quantity) for each AV space.
   5. Timetable
      a. Submit within thirty (30) days after award of contract.
      b. Submit simultaneously with Shop Drawings.
      c. Allow minimum of ten (10) business days for review. All sets minus one
         1) will be returned with review comments. If a resubmit is required, resubmit total quantity of complete sets. If second resubmit is required, Contractor shall reimburse Owner for expenses incurred during additional review process.
      d. Review and approval of Product Data is required before equipment purchase and installation.

C. Shop Drawings
   1. Minimum Number of Sets: four (4) or one (1) electronic copy.
   2. Timetable
      a. Submit within thirty (30) days after award of contract.
      b. Submit simultaneously with Product Data Binders.
      c. Allow minimum of ten (10) business days for review. All sets minus one
         1) will be returned with review comments. If a resubmit is required, resubmit total quantity of complete sets. If second resubmit is required, Contract shall reimburse Owner for expenses incurred during additional review process.
   3. Description:
      a. Shop Drawings shall be used for coordination between trades and updated as final record drawings.
      b. Bind all Shop Drawings together to form set. Loose drawings will not be accepted.
      c. Each drawing shall include: Project, Building, Location, Contractor Name, Architect, AV Consultant, Date and Revision Number.
      d. Number and title each drawing in logical manner as a set.
      e. Include cover sheet with listing of all drawings included in bound set.
      f. Ensure that labeling on Shop Drawings match labeling on equipment.
      g. Minimum Scale:
         1) Floor Plans: 1/8 inch (3.18 mm) = 1 foot (30.48 cm).
         2) Rack Elevations: 1-½ inch = 1 foot (30.48 cm).
         3) Plate/Panel Details: 6 inches (152.4 mm) = 1 foot (30.48 cm).
         4) Loudspeaker Details: 1 inch (25.4 mm) = 1 foot (30.48 cm).
      h. Include as a minimum:
         1) Floor plans indicating locations of all AV devices, vertical risers, pull boxes, and exposed wiring. Include Device ID (PRJ, SCREEN, FRK, FB, AVP, etc., as referenced in design contract documents), as appropriate for projectors, screens, racks, floor boxes, AV plates in walls, etc.
         2) Schematic diagram showing all primary and secondary devices, interconnectivity and signal flow.
         3) Plate details showing size, material, finish, connectors, engraving, etc.
         4) Mounting detail drawings of loudspeakers, racks, and overhead equipment. Hire services of professional structural engineer, licensed by the appropriate governing authority, to review shop drawings, building structural drawings, and

any existing structures from which equipment is to be suspended. Include Structural Engineer's stamped report with shop drawing submittal. Report shall include:
(a) Itemization of items reviewed by the Structural Engineer.
(b) Confirmation that proposed methods of suspending equipment as shown on the shop drawings conform to required safety factors.
(c) Confirmation that building structure from which equipment is to be suspended will support equipment including required safety factors.

5) Rack elevations.
6) Complete schematic diagram. One-line diagram with detailed descriptions of product inputs and outputs is acceptable. Include terminal strip details and cable label information. If wiring diagram spans more than three (3) sheets, additionally provide simplified block diagram of entire system on one (1) sheet.
7) Electrical power wiring diagram. Include circuit, switching, and control details.
8) Wiring diagram of grounding and shielding scheme.
9) Drawings for custom-fabricated items (i.e., plates, panels, cables, and assemblies).
10) General construction drawings necessary for completion of work.

D. Operation and Maintenance Manuals
1. Minimum number of Sets: four (4).
2. Bind Operation and Maintenance Manuals using either GBC or 3-ring binders.
3. Format and Minimum Information below:
a. Section 1 - System Operation.
1) Introduction/overview to system components and their functions and locations. Include a brief listing of basic system functions.
2) Complete but simple system operating instructions to accomplish basic system functions, written for non-technical personnel.
3) Certificate indicating names of Owner personnel trained by AV Contactor, date of training, name of AV Contractor representative that provided training, and name of project.
b. Section 2 - System Documentation.
1) Simplified system one-line schematic diagram showing changes made during construction.
2) Complete inventory of system components including serial numbers. Identify location (equipment rack, over stage, stored in control room, etc.) of each component.
3) Cable and terminal strip documentation including cable numbers, functions, originating locations, terminating locations, and signal levels.
4) All Shop Drawings corrected to reflect as-built conditions.
5) Other data and drawings required during construction.
6) Initial Tests and Adjustments data.
7) Final Tests and Adjustments data.
8) Electronic files including all utilized manufacturer's software and saved copies of software configurations (configurations as established during Final Tests and Adjustments).
c. Section 3 - Manufacturer's Documentation.
1) For each equipment model at no additional costs to Owner, even if manufacturer does not include costs of such documentation with purchase of equipment item.
2) Manufacturer's Product Data.
3) Operating instructions.
4) Installation instructions.
5) Service information.

6) Schematic diagrams.
7) Replacement parts list.

d. Section 4 - Maintenance Information.
1) Preventive maintenance schedule letter clearly stating target dates of six month and end-of-warranty preventative maintenance inspections, and list of maintenance tasks performed.
2) Maintenance instructions including manufacturer's recommended maintenance, recommended maintenance schedule and information concerning proper inspection, testing, and replacement of components.
3) Troubleshooting information complete with instructions for procedures during equipment failure.

e. Section 5 - Warranty Information
1) 1) System warranty letter.

4. Provide three (3) sets or an electronic copy that include all material in Operation and Maintenance Manuals in PDF format except for copyrighted material.
5. Submit one (1) set of Operation and Maintenance Manuals at least ten (10) days before Final Tests and Adjustments procedures (minus data from Final Tests and Adjustments). This set will be reviewed by Owner and returned to Contractor. Re- submit after Final Tests and Adjustments and include data. NOTE: Do not schedule Final Tests and Adjustments or perform training of Owner personnel before submitting Operation and Maintenance Manual.
6. Submit remaining number of complete manuals as required by General Conditions within ten (10) days after return of reviewed set(s). Include Final Tests and Adjustment data, warranty period letter, and any other data not included in first submission.

E. Samples.
1. Request for Samples - Upon request, furnish samples (at no additional cost) to Owner and/or General Contractor of submitted items proposed as substitutes for specified items. Products will be reviewed to determine if proposed substitute items meet required function and quality.
2. Product Tests
a. Products submitted as samples may require testing by independent laboratory. Testing at expense of Contractor.
b. Obtain written approval of tested products before incorporating into system.

1.05 AS-BUILT DRAWINGS

A. Submit one electronic copy and one hard copy with project deliverables within three (3) weeks subsequent to substantial completion. Minimum Number of Sets: four (4) or one (1) electronic copy.

B. The As-Built drawings shall incorporate all changes made to the building identified in, but not limited to, addendum, change notices, site instructions or deviations resulting from site conditions.
1. Contractor shall clearly identify any resubmitted drawing sheets, documents or cut sheets either by using a color to highlight or cloud around resubmitted information.
2. Maintain drawing numbering or page/sheet scheme consistency as per previously issued Shop drawings/documents.

1.06 QUALITY ASSURANCE

A. AV Contractor Qualifications.
1. Be established AV System Contractor, regularly engaged in furnishing and installing AV systems. NOTE: Electrical or general contracting firms responsible for completion of this work, but not meeting above requirement, shall employ services of approved AV Contractor as subcontractor to perform work described herein.

2. Be experienced in installations of similar size and scope within last five (5) years. Submit list of four (4) (minimum) installed jobs of similar magnitude, completed within last five years. For verification, submit complete information, including project name, project address, contact person, daytime telephone number plus month and year of project completion. At Owner's request, accompany Owner or Owner's representative on visit to any or all example completed projects submitted.
3. Be Authorized Dealer for all major lines of equipment listed in Part 2 (Biamp, Chief, Extron, Crestron, JBL, Middle Atlantic, Shure, etc.) Must have at least one permanent staff member who is factory trained in the installation and maintenance of each major product line offered.
4. Employ personnel (at all levels of work) experienced in projects of similar size and scope. Provide list of key personnel to be responsible for each of the following aspects of work: Project Management, Technical Documentation, Control System programming, DSP programming and Leadership of Field Work (one who is present for all field work). For each identified employee, indicate number of years employed by contractor, number of years experience in assigned responsibilities, and list of previously completed projects where similar responsibilities were required.
5. Project manager assigned to this project must have a minimum of five (5) years experience in installing and integrating AV systems of similar scale. Project Manager shall also have either an AVIXA CTS-I or CTS-D certification.

1.07 PRODUREMENT

A. Refer to 270000

B. Technology Implementation Plan shall be provided during the submittal review process.

PART 2 - PRODUCTS

2.01 GUIDELINES

A. Infrastructure Products - All conduits, basket tray/cable tray, pull boxes and associated parts required for infrastructure shall be installed by the electrical contractor unless specifically excluded in these specifications or drawings.

B. Performance - Regardless of completeness of descriptive paragraphs herein, each device shall meet its manufacturer's published specifications. Verify performance.

C. Contract Documents - Drawings and specifications are to be used in conjunction with one another and to supplement one another. In general the specifications determine the nature and quality of the materials, and the drawings establish the quantities, details, and give characteristics of performance that should be adhered to in the installation of the AV system components. If there is an apparent conflict between the drawings and specifications, the items with the greater quantity or quality shall be provided and installed. Clarification with the owner about these items shall be made prior to the ordering and installation.

D. Quantities - All quantities are indicated on AV drawings or in Part 2 AV Products list. Confirm quantities on final Contract Documents. If Contract Documents do not include quantities necessary to deliver complete working system, provide notification of disparity, and install required quantity of devices for complete working system.

E. Small Parts - Systems are described in terms of major products. Even if not specifically mentioned, provide and install patch cables, connectors, hardware, converters, power supplies, labels, terminals, mounting accessories etc. necessary for complete and working system meeting design intent of specifications.

F. Keys - Provide five (5) sets of keys for any AV system product requiring keys.

G. Condition - Provide and install products listed in this section in factory new condition, conforming to applicable provisions of American National Standards Institute.

H. Designations - Each major product item is given unique designation (such as MIX1 for mixer number 1). The product designations are unique in this section only and may be repeated in other specification sections.

I. Security Screws - Use Bryce Security Penta-Plus button-head screws and bits to secure rack components, LCD mounts, Projector mounts and any other location deemed necessary by Owner. Use nylon washers (not provided by Bryce) to protect equipment surfaces. Account for appropriate tip wear when ordering quantity and do no use a bit beyond the manufacturer's recommendations. Provide ten (10) additional unused driver bits and deliver to the customer after completion.

J. AV Electrical Power - Coordinate with Electrical Contractor regarding proper placement of isolated-ground duplex outlets for any AV equipment. Electrical circuits should be connected (and outlets wired) by the Electrical Contractor to the AV system circuit breaker panel (N.I.C.). Ensure that "Star" ground configuration is properly implemented by the Electrical Contractor. Ensure that ground wires from each outlet are isolated from conduit, neutrals, and each other.

K. AV Screens - For any screen specified, size as indicated in drawings. Unless otherwise indicated in drawings or specifications, set limits so projected images are 48" above finished floor, and include additional black drop as appropriate considering screen size and mounting height.

L. AV Racks:
   1. Provide blank faceplate in any area marked BLANK in drawings.
   2. Provide shelf for mounting of any device for which rack mount kit is not available.
   3. Provide one (1) Panelcrafters AAA-XXXXX-RHIM-01 designer/integrator information plate or approved alternate per rack. Install information plate at the top of each rack unless 1RU space is not available. Contact Panelcrafters sales department to add AV Contractor graphic to the "integrator" section (approximately 8.5" x 1.75" of the right-hand side). All alternates must include AV Consultant graphic. Submit to AV designer for approval of final plate design prior to purchasing and installation.

M. AV Floor Boxes:
   1. Clean floor boxes of all dust and debris prior to installation of any active or connectorized plate.
   2. Any floor box with active or connectorized AV plates found to have any dust, debris or water in bottom of box are subject to replacement of all plates and components. A re-test of all associated components must be completed.

N. Wireless Microphones - Coordinate frequency selection with other radio-frequency sources in the area and with manufacturer's recommendations.

O. Control System Programming:
   1. Program each panel to provide simple, intuitive control of all basic AV functions including:
      a. program and speech volume levels
      b. video source and destination routing
      c. screen control
      d. video projector lift control (where applicable)
      e. AV system power
      f. media player transport functions
      g. video conferencing CODEC controls including call initiation (where applicable)
      h. video conferencing PTZ camera control (where applicable)
      i. combine/uncombine settings for all combinations of controlled rooms
      j. local lighting and blackout shade controls (where applicable)
   2. Utilize AVIXA's "Dashboard for Controls" concept unless directed otherwise by Owner.
   3. Provide layout of each and every touch panel and hard-button panel pages in the product data submittal for approval by Owner.

4. Provide web-control for each touch panel in AV system. Include page tracking, and track current button feedback between touch panel and web-control panel.
5. Staff member certified by control system manufacturer shall program control system.
6. After programming is approved, all control system code and programming, including touch panel code and graphics, will become the property of Owner. AV Contractor shall provide Owner an electronic copy of both raw and compiled code.
7. Provide follow up meeting with Owner after 6 months of operation to make updates as requested to control programming.

P. Audio System Programming - Owner shall coordinate layout and logical branching of DSP audio system. Include screen layout and menu branching drawings in AV submittal. After AV system is approved, all audio control system code and programming will become property of Owner. AV Contractor shall provide Owner an electronic copy of both raw and compiled code.

Q. AV Design Bid
1. System design is around products listed in Part 2. Intent of product specification is to provide standard of quality and function for installed materials. Certain performance specifications are given to clarify job requirements.
2. Bid AV system with products specified in Base Bid section below unless noted otherwise from Owner.

2.02 PRODUCT SUBSTITUTION

A. For products listed as “or approved equal”, substitution products from different manufacturers are allowed. Include written substitution request with product submittal for review and approval.

B. Product substitution shall not void, alter or change manufacturers’ structured cabling system warranty.

C. Document substitution requests with complete data substantiating compliance of proposed substitution with Contract Documents. Include the following in each request for substitution:
1. Product identification, manufacturer’s name and address
2. Reason for the substitution
3. Product Data:
a. Description, performance and test data, reference standards, finishes and colors.
b. Samples: Finishes.
c. Complete and accurate drawings indicating construction revisions required (if any) to accommodate substitutions.
d. Data relating to changes required in construction schedule.
e. Cost comparison between specified and proposed substitution.

D. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

2.03 AV PRODUCTS - ACTIVE EQUIPMENT

A. Room Scheduling System
1. Room Scheduler Product: Evoko Lisa Room Manager ERM2001 (no substitution)
2. Provide one (1) Data drop and mounting bracket for each scheduler.
3. All schedulers shall be furnished and installed by contractors, and configured by OWNER. Coordinate with OWNER in advance for IP address and device configuration.

B. Digital Signage System
1. Digital Signage Player
a. HD2-FHD100 (Full HD, default option for typical installation)
b. HD2-BXP100 (4K, only used at locations with space constraints)
c. No Substitution.
d. Provide one (1) Enterprise license for each digital signage player installed

e. The digital signage player should be connected to the IT network via WiFi. Verify the WiFi coverage before installation.

2. Digital Signage TV
   a. Samsung # QA65QN90CAUXTW (4K QLED Smart 65” TV)
   b. Consult with OWNER and provide larger display (up to 85”) where viewing distance exceeds 8-ft.
   c. Consult with End User department and OWNER for the size and model of Outdoor display devices.
3. Digital Signage Display Mounting Bracket
   a. Chief # LTA1U
4. In-Wall Storage Box (for all installations on drywall partitions)
   a. Chief PAC525FW
5. All digital signage system shall be furnished and installed by contractors, and configured by OWNER. Coordinate with OWNER in advance for IP address and device configuration.
6. All installations shall be ADA-compliant.

C. Huddle Room (25-75 sqft, 1-2 people) – Standard Solution
   1. Provide Cisco Desk product for video conferencing, AV presentation, digital whiteboarding and annotation
   2. AV Products
      a. One (1) Cisco Desk (24” touch screen for 1-person) or Cisco Desk Pro (27” touch screen for 2-person)

D. Small Conference Room (100-150 sqft, 1-5 people) – Standard Solution
   1. Provide a TV and all-in-one video conference bar for video conferencing and AV presentation (No touch screen for digital whiteboarding).
   2. AV Products
      a. One (1) Cisco Room Bar
      b. One (1) Cisco Room Navigator
      c. One (1) 55” 4K TV (Samsung QM55C or approved equal)
      d. One (1) Chief LTA1U Tilt Wall Mount
      e. One (1) Chief PAC525FW In-Wall Storage Box

E. Small Conference Room (100-150 sqft, 1-5 people) – Special Request
   1. Provide an interactive TV with built-in system for video conferencing, AV presentation, digital whiteboarding
   2. AV Products
      a. One (1) Cisco Board Pro 55
      b. Wall Mount or wheel stand option

F. Medium Conference Room (150-390 sqft, 6-10 people) – Standard Solution
   1. Provide a TV and all-in-one video conference bar for video conferencing and AV presentation (No touch screen for digital whiteboarding).
   2. AV Products
      a. One (1) Cisco Room Bar Pro
      b. One (1) Cisco Room Navigator
      c. One (1) 75” 4K TV (Samsung QM75C or approved equal)
      d. One (1) Chief LTA1U Tilt Wall Mount
      e. One (1) Chief PAC525FW In-Wall Storage Box

G. Medium Conference Room (150-390 sqft, 6-10 people) – Special Request 1
   1. Provide (2) TV and all-in-one video conference bar for video conferencing and AV presentation (No touch screen for digital whiteboarding).
   2. AV Products
      a. One (1) Cisco Room Bar Pro

b. One (1) Cisco Room Navigator
c. Two (2) 55” 4K TV (Samsung QM55C or approved equal)
d. Two (2) Chief LTA1U Tilt Wall Mounts
e. Two (2) Chief PAC525FW In-Wall Storage Box

H. Medium Conference Room (150-390 sqft, 6-10 people) – Special Request 2
1. Provide an interactive display with built-in system for video conferencing, AV presentation, digital whiteboarding
2. AV Products
a. One (1) Cisco Board Pro 75
b. Wall Mount or wheel stand option

I. Large Conference Room (400+ sqft, 10-20 people) – Standard Solution
1. Provide TVs and video conference devices for video conferencing and AV presentation (No touch screen for digital whiteboarding).
2. AV Products
a. One (1) Cisco Codec Pro
b. One (1) Cisco PTZ 4K Camera (on back wall)
c. One (1) Cisco Quad Camera (on front wall)
d. One (1) Cisco Room Navigator
e. Two (2) 75” 4K TV (Samsung QM75C or approved equal) on front wall
f. One (1) 75” 4K TV (Samsung QM75C or approved equal) on back wall
g. Three (3) Chief LTA1U Tilt Wall Mount
h. Three (3) Chief PAC526FW In-Wall Storage Box (one per TV)
i. One (1) Ceiling Array Microphone+Speaker (Shure MXA902)

J. Large Conference Room (400+ sqft, 10-20 people) – Special Request
1. Provide TVs and video conference devices for video conferencing and AV presentation with one touch screen for digital whiteboarding.
2. AV Products
a. One (1) Cisco Room Kit EQX (includes Codec EQ, Quad Camera, Room Navigator and mounting kit)
b. One (1) Cisco PTZ 4K Camera (on back wall)
c. Two (2) 75” 4K TV (Samsung QM75C or approved equal) on front wall
d. Two (2) Chief PAC525FW In-Wall Storage Box
e. One (1) Cisco Board Pro 75” (in companion mode), with wall mount or wheel stand
f. One (1) Ceiling Array Microphone+Speaker (Shure MXA902)
g. One (1) Ceiling Storage Box (Chief CMS492)

K. Training Room (400+ sqft, 20+ people) – Standard Solution
1. Provide TVs and video conference devices for video conferencing and AV presentation (No touch screen for digital whiteboarding).
2. AV Products
a. One (1) Cisco Codec Pro
b. One (1) Cisco Navigator
c. Two (2) Cisco PTZ 4K Camera (one front wall, one at center of finish ceiling)
d. Two (2) 85” 4K TV (Samsung QM85C or approved equal) on front wall
e. One (1) 65” 4K TV (Samsung QM65C or approved equal) on back wall
f. Three (3) Chief LTA1U Tilt Wall Mount
g. Three (1) Chief PAC525FW In-Wall Storage Box (one per TV)
h. One (1) Shure QLXD 124/85 Wireless Receiver Combo
i. Ceiling Speakers Extron SF 26CT (Qty: as needed based on the size of the room)
j. One (1) Audio Amplifier (Extron XPA2001)
k. One (1) HDMI connection at lectern location

l. Wall mounted equipment rack: Middle Atlantic
m. Power Distribution Unit: Middle Atlantic PDS-615R

L. Auditorium/Courthouse
1. Customized AV solution is needed for these spaces. Consult with the End User department and OWNER Representative for exact function and system requirements.
2. Video Transmission, Switching and Control
a. Product Manufacturer: Extron
3. Wireless Presentation Gateway
a. Product Manufacturer: Clickshare C-10 (one button)
4. Audio DSP
a. Product Manufacturer: Extron/Biamp
5. Audio Amplifier
a. Product Manufacturer: Crown/QSC
6. Audio Mixer
a. Product Manufacturer: Allen & Heath (SQ5, UON)
7. Microphones
a. Product Manufacturer: Shure
8. Speakers
a. Product Manufacturer: Electro Voice / Community
9. Projectors (laser projector only)
a. Product Manufacturer: Epson/Sony/Christie
10. Electric Projection Screen
a. Product Manufacturer: Da-lite / Draper
11. Equipment Cabinet
a. Product Manufacturer: Middle Atlantic
12. Flat Panel Display (4K LED)
a. Product Manufacturer: Samsung, LG, Panasonic, Sony
13. TV mount bracket
a. Product Manufacturer: Chief

2.04 CABLES

A. Interconnect Wiring – Provide and install following cable as required for connections in all areas. Meet provisions of N.E.C. Provide plenum rated cable where required.
1. Analog Audio/Microphone cable - West Penn D25291.
2. Digital Audio Plenum Rated Cable: West Penn DA252401/ DA252402/ DA252406, or AES/EBU compliant equivalent.
3. Analog Composite Video Plenum Rated Cable: West Penn 25806.
4. RGBHV Plenum Rated Cable: West Penn 258195.
5. Control Plenum Rated Cable: West Penn D25350.
6. Low Impedance Loudspeaker Cable
a. For cable distance <50’: 14-guage 2-conductor West Penn #25226B
b. For cable distance from 50’ to 100’: 12-guage 2-conductor West Penn #25227B
c. For cable distance ??? 100’, consult with manufacturer and engineer before ordering/installation.
d. Terminate with Neutrik “Speakon” type connectors when available.
7. High Impedance Loudspeaker Cable (25v/70v)
a. For cable distance <300’: 18-guage 2-conductor West Penn #25224B
b. For cable distance from 300’ to 500’: 16-guage 2-conductor West Penn #25225B
c. For cable distance ??? 500’, consult with manufacturer and engineer before ordering/installation.
d. Terminate with Neutrik “Speakon” type connectors when available.

8. HDMI cables: Belden HD-800 series. All HDMI cables used shall be certified to meet the performance of the display devices over the actual cable length. Provide HDMI transmitters and receivers as needed.
9. HDBaseT Cable: Belden 2183P (or as manufacturer recommended).

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Guidelines

1. Quality of Work - Perform labor to accepted industry standards and state and local codes to accomplish complete and working system.
2. Material and Labor - Provide specified products and other incidental materials, appliances, tools, and transportation required for complete and functioning systems. Provide personnel to perform labor who are skilled in techniques and can demonstrate technical knowledge AV infrastructure system installations.
3. Provide a complete functioning sound system that's been fully tested and properly balanced, configured, and equalized. Be of maximum assistance to the Owner during the warranty period of the system, to the degree that maximum Owner satisfaction is assured.
4. Observe proper circuit polarity and loudspeaker wiring polarity. No cables shall be wired with a polarity reversal between connectors with respect to either end. Special care shall be taken when wiring microphone cables, to ensure that constant polarity is maintained. Balanced audio connectors shall be wired as follows.

Wire	Connector	Signal
Black	Pin #3 or Ring	Low or Negative
Red or White	Pin #2 or Tip	High or Positive
Bare	Pin #1 or Shield	Ground

5. Provide all audio circuits balanced and floating, except as noted in the Specifications or directed by the Consultant at the time of final equalization and testing. Shields of audio cables shall be grounded at one end only, at the outputs of the various equipment items in the system
6. Route cables and wiring within equipment racks and cabinetry according to function, separating wires of different signal levels (video, microphone level, line level, amplifier output, 120VAC, intercom, control, etc.) by as much physical distance as possible. Neatly arrange and bundle all cables loosely with plastic cable ties. Cables and wires shall be continuous lengths without splices.
7. All system wire, except spare wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means. No unterminated wire ends will be accepted. Heat-shrink type tubing shall be used to insulate and dress the ends of all wire and cables. Include a separate tube for the ground or drain wire.
8. All cables in conduits shall be insulated from each other and from the conduit the entire length and shall not be spliced. All cables and wires are to be continuous lengths without splices.
9. All solder joints and terminations shall be made with resin-core silver solder. Temperature regulated soldering irons rated at least 60 watts shall be used for all soldering work. No soldering guns or temperature unregulated irons shall be used on the job site.
    a. and shall not be used on the job site.
10. Label all wires in racks and console as to destination and purpose with permanent labels. Clearly and permanently label all controls and connections at the front and back of the rack, with permanent labels. Wall plates and custom panels shall be engraved and filled with contrasting paint, unless otherwise noted. All labeling shall be completed prior to final system inspection.

11. Documents at Job Site - Keep following documents at job site during entire construction period:
    a. Complete Specifications and Drawings.
    b. Approved Shop Drawings.
    c. Approved Product Data.
    d. Progress Set of Project Record Documents.
12. Mounting - Mount equipment and enclosures plumb and square. Ensure that permanently installed equipment is firmly and safely held in place. Design equipment supports to support loads imposed with project safety factor of five (5) or greater. For devices hung overhead, obtain review by Structural Engineer licensed by the appropriate governing authority prior to installation.
13. Locate wireless microphone system and hearing assist system antennas at or above ceiling or at bar joist height in areas without ceilings. Coordinate exact location with Owner to provide adequate coverage in the area served by the system. Adjust antenna location for best possible reception/transmission in area of coverage.
14. Provide adequate protective vandal guards for all devices located in areas subject to damage from activities or vandalization, such as school gym, sports field, school cafeteria.
15. Provide hearing assist transmitter(s) and receivers for each sound reinforcement system. The quantity of hearing assist receivers for each system shall be equal to a minimum of four (4) percent of the total seating capacity, but in no case less than ten (10) receivers for the area of coverage of each local sound reinforcement system.
16. Dimension Verification - Verify dimensions and space requirements to assure that proper mounting, clearance, and maintenance access space is available for system components.
17. Clean-Up - Leave project clean each day. Place debris where designated by General Contractor. Debris includes but not limited to: solder splatter, cable ends, stripped insulation, spent crimp connectors, gypsum board and ceiling tile dust, and product wrappings and cartons. After completion of installation, thoroughly clean areas worked, including non-visible areas such as equipment rack interiors, rack top panels, and inside lockable floor and wall boxes.
18. Coordinate installation of AV infrastructure and equipment with other trades in order to follow project schedule.
19. Maintain any licensing required by the appropriate governing authority to install and terminate low voltage systems.

B. Labeling
    1. Equipment Labels - AV Contractor shall provide engraved lamicoid labels on front and rear of rack-mounted equipment. Mount labels plumb and square. Include schematic reference design, item name, and system or area controlled by labeled component. On program preamps and mixers, provide label for each input indicating which source is controlled by labeled channel. Unless otherwise indicated, provide permanently-mounted black labels engraved with 1/8-inch white block characters. Handwritten, self-laminating, or embossed plastic (Dymo) labels are not acceptable. Provide labels for major equipment with two (2) lines (minimum) of engraving, coded as follows:
        a. Line 1: Generic name of device, such as MIXER AMPLIFIER.
        b. Line 2: Schematic designation of device, such as AV-MSW-1.
    2. Control Labels - AV Contractor shall provide engraved label over each user- operated control that describes the function or purpose of control. Provide label of proper size to fit available space.
    3. Terminal Strip Labels - AV Contractor shall label each terminal strip with unique identification code in addition to numerical label (Cinch MS series) for each terminal. Show terminal strip codes on system schematic drawings included with Project Record Documents.
    4. Rear Equipment Labels - AV Contractor shall provide adhesive label on rear of equipment where cables attach, to indicate designation of cable connected at each point.

5. Cable and Wire Labels - Label cables and wiring logically, legibly and permanently for easy identification. Labels on cables shall be adhesive strip type, covered with clear heat shrink tubing. Factory stamped heat shrink tubing may be used. Hand- written or self-laminating type labels are not acceptable.
6. Cable Label Codes and Locations - Label each cable with unique alpha-numeric code. Locate cable designation at start and end of each cable run, within three (3) inches of termination point. For cable runs that have intermediate splice points, label cable with same designation throughout, with additional suffix to indicate each segment of run. Provide cable designation codes to schematic drawings included with Project Record Documents and Operation and Maintenance Manuals.

C. Power and Grounding
1. Power Coordination - Coordinate final connection of power and ground wiring to rack. Electrical contractor will provide power to AV systems. Before installation, verify load requirements for systems as accepted.
2. Bus Bars - Install 1-inch by 1/4-inch copper ground bus bar, top to bottom in floor mounted AV racks. Ground and bond equipment chassis of each rack-mounted component without three-pin grounding plug to bus bars with #12 AWG insulated green wire using 6-32 or larger nuts, bolts, lock-washers, and appropriate NEMA connectors. Electrical Contractor (Division 26) shall provide and connect #4 AWG green insulated wire from Bus Bars to ground point in AV technical electrical panel.

D. Equipment Racks
1. Ventilation - Provide ventilation adequate to keep temperature in rack below 85 degrees Fahrenheit. Use “whisper” type ventilation fans in racks, adjusted to come on when temperature in rack rises above 85 degrees Fahrenheit, only if adequate cooling cannot be provided by Owner.

E. Wiring
1. Wiring Standards - Execute wiring in strict adherence to best AV engineering practices.
2. Field Connection Devices - Connect cable to active components through screw terminal connections and spade lugs when appropriate. For BNC connections use three-piece, dual crimp BNC properly sized for cable with insulating bushings. Wire nut or “Skotchlock” connectors are not acceptable. Do not wrap audio cable splices or connections with adhesive backed tape. Punch connectors or telephone-style punch blocks are not acceptable anywhere in the installation unless specifically authorized by Owner.
3. Run cable in ceiling plenums neatly parallel to building walls, supported every three feet to structure with plenum rated ties.
4. Raceways - Run vertical wiring inside rack in Panduit (or equivalent) plastic raceways with snap-on covers, sized to allow at least 50% future wiring. Mount raceways on full length 3/4-inch flat black plywood backboards, attached to rack sides. If between-rack wiring chases are provided, Panduit raceways are not required. Horizontal wiring in rack shall be neatly tied in manageable bundles with cable lengths cut to minimize excess cable slack, but still allow for service and testing. Provide horizontal support bars if cable bundles sag. Individually bundle excess AC power cable away from rack mounted equipment with plastic cable ties. Electrical tape and adhesive backed cable tie anchors are not acceptable.
5. Accessibility - Ensure that wiring and connections are completely visible and labeled in rack. Mount termination resistors, if required, on terminal strips, fully visible and not concealed within equipment or connectors.
6. Loudspeaker Polarity - Connect loudspeakers electrically in phase, using same wire color for loudspeaker wiring throughout project.
7. Physical Damage Prevention - Take necessary precautions to prevent physical damage to cables and equipment. Damaged cables or equipment will not be accepted. Separate, organize, and route cables to restrict channel crosstalk and feedback oscillation.

8. Racks - Looking into the rack from the rear, locate AC power, control, data and speaker wiring on the left; line level audio, control, video, and RF wiring on the right. Keep several inches of space between power cables and other signals.
9. Other Connections - Make connections using rosin core solder or approved mechanical connectors. Where spade lugs are used, crimp properly with ratchet type crimping tool. Solder spade lugs mounted on #22 AWG or smaller cable after crimping.

3.02 FIRESTOPPING

A. Refer to section 27 00 00.

3.03 STORAGE AND HANDLING

A. Power up any electronic equipment to ensure its proper functioning before its arrival onsite.

B. Ensure that materials (especially electronic and electro-acoustic devices) are protected against physical, environmental, and electronic damage until final acceptance by Owner.

C. Schedule delivery to minimize delays in the project.

D. Provide storage protection against temperature and humidity extremes, theft, vandalism, physical damage, and environmental damage.

3.04 WARRANTY

A. Refer to Division 1.

B. Warranty - Submit letter providing warranty covering labor and materials supplied under this contract. Bind in Operation and Maintenance Manuals. Terms as described in General Conditions. Minimum terms as follows:
   1. System - Systems shall be free of manufacturing or installation defects for a minimum period of one (1) year from the date of final acceptance. Clearly designate begin and end dates of system warranty period.
   2. Parts and Labor - Provide parts and labor to repair defects in materials and workmanship during system warranty period.
   3. Response Time - Within system warranty period, provide initial on-site service response within one (1) business day of service call. Provide resolution to any system defects within 72 hours or within 48 hours of receipt of repaired or replaced product from manufacturer.
   4. Replacement Products - If any item must be removed for repair during system warranty period, provide replacement item of similar quality at no charge.
   5. Repair Limit - Do not repair any piece of equipment found defective during installation or system warranty period more than two (2) times. After second repair, replace defective item with similar approved item at no additional cost to Owner.
   6. Extended Manufacturer’s Warranties - Identify products with manufacturer’s warranties extending beyond one (1) year. Provide terms and conditions of such warranties.
   7. Service Personnel Information - Provide name(s) and telephone number(s) of service personnel to be contacted regarding repair and maintenance.

C. Extended Warranty - Provide cost to extend complete AV system warranty from one (1) year to three (3) years. Included a list of all provided services including maintenance schedules.

3.05 INITIAL TESTS

A. Purpose - These tests are to ensure that the AV system is installed and functioning as specified, and to ensure the system is ready for Final Tests and Adjustments (described later).

B. Testing Standards - Perform testing in accordance with ANSI standards.

C. Inspection - Verify prior to beginning actual tests and adjustments on systems:
   1. Proper grounding of all electronic components (through third prong of power connector or separate connection between component chassis and ground bus bar).
   2. Cables dressed, routed, and labeled, connected with proper polarity.
   3. Insulation and shrink tubing in place.

4. Dust, debris, solder splatter, etc. removed.
5. Proper frequency settings (or modules) at crossovers and controllers.
6. All equalizer bands and tone controls set for flat frequency response.
7. Survey temperatures of each piece of equipment after four (4) hours use (minimum). Note and report any hot equipment.

D. Electrical Power Quality - While all sound and AV system components are unplugged from electrical power outlets, AV Contractor shall turn on power to outlets, and confirm proper voltages at each outlet across the following pairs of terminals: hot and neutral, hot and ground, and neutral and ground (zero volts across neutral and ground). AV Contractor to document measurements.

E. General Function Tests - Test each piece of equipment to ensure that it performs its intended function. Include all portable equipment in tests. Intent of initial tests is to verify complete, functioning system before Final Tests and Adjustments. Correct problems found during initial testing before beginning Final Tests and Adjustments. Document whether all pieces performed intended functions; note any unresolved malfunctions.

F. Initial Tests and Adjustments Data - Submit written report of Initial Tests and Adjustments data upon completion to Owner. Include printed name(s) of technician(s) performing tests, date(s) and time(s) of tests, model and serial numbers of test equipment, results of each initial test, descriptions of problems encountered and their solutions, and statement that system is ready for Final Tests and Adjustments. Initial Tests and Adjustments Data to include signatures of technician(s) performing tests.

3.06 FINAL TESTS AND ADJUSTMENTS

A. Purpose - These tests are to be witnessed by AV Consultant to determine if system is complete and functioning as designed and specified. Also, AV Consultant will perform listening and viewing tests and witness adjustments of all images for optimum clarity.

B. Timetable - Coordinate with Owner, General Contractor, and AV Consultant to schedule Final Tests and Adjustments after submittal of Initial Tests and Adjustments data.

C. System and Site Conditions - AV Consultant will witness Final Tests and Adjustments. Have systems fully functional and ready for observation and testing upon AV Consultant’s arrival. Coordinate with all trades for quiet conditions throughout the listening areas and for the duration of the test schedule. If upon AV Consultant’s arrival, systems do not meet criteria, site is not sufficiently quiet, or if Owner or AV Consultant is required to make additional trips to job site to witness additional testing or perform additional reviews of installed equipment, Contractor shall reimburse Owner for labor and expenses incurred by having incurred costs deducted from payments to contractor.

D. Test Labor - Provide technician familiar with this project’s AV systems and operation of test equipment to perform testing. Provide additional technician to assist in the tests and to perform troubleshooting, repairs, and adjustments. Include labor for these technicians to be present for one (1), eight (8)-hour day during Final Tests and Adjustments.

E. Tools - Provide standard hand tools including screwdrivers, pliers, wire strippers, nut drivers, soldering iron, and other tools appropriate for troubleshooting system problems.

F. Ladders and Scaffolds - Provide ladders and scaffolds to inspect/adjust loudspeakers and rigging points.

G. Verification of Initial Tests and Adjustments - Verify that Initial Tests and Adjustments have been performed and meet criteria. During Final Tests and Adjustments, AV Consultant may require portions of the Initial Tests and Adjustments to be repeated. Repeat measurements as requested without claim for additional payment.

H. Installer shall perform thorough preliminary testing of the AV Systems prior to the final inspection by the Consultant. All systems and subsystems shall be tested to ensure that they

are in proper working order and meet the performance specifications. Perform preliminary programming and setup of digital signal processors as necessary to conduct these tests.

I. The testing and equalization work shall be performed after the installation work has been completed, but prior to any use of the system. During the testing and equalization work, the Installer shall have on the job site one (1) competent technician who is familiar with the project, and who will be prepared to stay as long as his services are needed. It is estimated that approximately eight (8) hours will be required for this work

J. The process of equalizing and testing the system may necessitate moving and adjusting certain loudspeakers. Adjustments shall be performed without claim for additional payment.

K. Coordinate as necessary to ensure a totally quiet room during the sound reinforcement systems testing and balancing period.

L. Prior to requesting systems testing, verify the following:
   1. All systems are in first-class working condition and free of short circuits, ground loops, parasitic oscillations, excessive system noise beyond published.
   2. All specified equipment, including loose equipment, is on the job site for proper accounting.
   3. All loudspeaker circuits have been tested, are connected to the proper crossover frequency, and are in perfect working order. Furnish impedance measurements of each circuit in PDF format prior to final tests.
   4. All video systems and associated control systems have been tested and are in perfect working order.
   5. All equipment controls shall be labeled, even if unused. If permanent labels cannot be furnished prior to system inspection, temporarily label every control on the front and in the rear of the racks as to its function with write-on tape. Supply printer labels or markers suitable for permanently indicating knob settings after equalization is performed.
   6. Operation manuals for every equipment item furnished are on hand at the job site.
   7. Installer shall provide all signal processing software loaded on a portable PC and ready for use at time of testing. Installer shall provide a calibrated RTA and microphone, and pink noise generator at time of testing.

M. Should the performance testing show that the Installer has not properly completed the systems, the Installer shall make all necessary corrections or adjustments and a second demonstration shall be arranged at the Installer's expense.

N. The final acceptance of the system by the Owner will be based upon the report of the Consultant following inspection, testing, and demonstration. A list of items in need of completion or correction shall be generated by the Consultant, which must be corrected by the Installer before final acceptance will be granted.

3.07 SOUND SYSTEM PERFORMANCE

A. After equalization and testing, the sound system shall meet or exceed the following specifications:
   1. System shall be free of short circuits, ground loops, parasitic oscillation, excessive system noise, hum, RF interference, and instability of any form.
   2. Minimum SPL with band-limited pink noise input to the system in the targeted space shall be 95 dB before audible distortion occurs.
   3. Seat-to-seat variation in SPL at 4kHz octave band pink noise shall be within a tolerance of plus or minus 3dB SPL.
   4. Acoustic response of the system shall be plus or minus 1.5dB along a line which is flat from 50 Hz to 4000 Hz and which rolls off at 1dB per octave to 16kHz.

B. The following tests and adjustments shall be performed by the Contractor.. Make all necessary corrections to bring systems into specification compliance. Record the results of these tests in

project record drawings. Submit written results of tests to Architect and Engineer prior to scheduled equalization and final inspection date.

1. Measure and record impedance of each speaker line at frequency of 1,000 Hz, with loudspeakers connected to their respective lines.
2. Measure and record overall system hum and noise level of each input channel with controls set so that -50 dBm microphone input or +4 dBm input would drive the system to full amplifier output. Terminate inputs with resistor (150 to 600 ohms) and disconnect power to noise generator for this test.
3. Adjust the gain of each active device to provide both optimum signal - to noise ratio, and at least 10 dB headroom at each active device. Observe the output of each active device with an oscilloscope of 5 MHZ band width, and verify visually that the signal required for full amplifier output is free of overload, clipping, parasitics, and radio frequency components. Adjust gain structure of all active components and record the input and output signal levels of all active components and record the input and output signal levels of all active components in both dBm and volts, during normal program levels.
4. Measure and record system electrical frequency response for each input channel through power amplifier. Required is flat response with permissible deviation of +/- 1 dB within the range of 30 Hz to 16 kHz.
5. Check system to assure freedom from oscillations or stray RF pickup. Check inputs with no signal and with typical program material driving system to full output Detect unwanted signals on Oscilloscope at termination.
6. Check phasing of loudspeakers by applying constant power per octave (pink) noise to system and walking through the transition areas of coverage from one loudspeaker to the next. Transition should be smooth with no apparent shift in source from one speaker to the next. Apply sine wave sweet signal to each loudspeaker system sweeping from 50 Hz to 5,000 Hz and at a level of 10 Db below full amplifier output, and listen for rattle or objectionable noises Correct if apparent.
7. Achieve uniform distribution of sound from each loudspeaker (with bleachers in their extended position in gymnasium where applicable). Drive system with broadband, constant power per octave (pink) noise, and measure the SPL using a sound level meter incorporating an octave-band filter centered at 4 kHz. Adjust noise level until the meter readings are between 75 and 80 dB. Use a sound level meter filter that meets ANSI S1 4-1971 Type 2 and ANSI S1 11-1971 standards set for slow meter damping. Take all readings at seated ear height. Adjust speaker as necessary to achieve +/-3 dB over entire area covered by this system.

3.08 FINAL ACCEPTANCE BY OWNER

A. Certificate - Submit Certificate of Final Acceptance form signed by Owner verifying complete installation and proper operation of systems upon fulfillment of all requirements and upon recommendation by Owner.

B. General Adjustments - Adjust, balance, and align equipment for optimum quality, meeting manufacturers published specifications.

C. Input/Output Jack Demonstration - Demonstrate proper performance and phase of each system input and output jack (all audio input and output jacks) as received at AV and network systems.

D. Inventory - Inventory all installed and portable equipment for correct quantities.

E. Functional Demonstration - Demonstrate operation of each function of each major piece of equipment.

F. Other Tests - Perform any other tests on any part of the AV system as requested by Owner.

G. Final Equipment Settings - Record final settings of all equalizer bands, tone controls, filters, delays, limiters, etc., including those established through computer software settings. Include descriptions of settings (including software settings) in Operation and Maintenance Manual. Include software copy of configuration file(s) in Operation and Maintenance Manual.

H. Security Inspection - Inspect equipment for security from tampering (covers, shaft-locks, etc.).

I. Review of Labels - Review installed labels on cables, equipment, controls, and terminal strips.

3.09 OWNER TRAINING

A. Provide Owner training as described in General Conditions. As a minimum, provide eight
   1. (8) hours instruction (within two (2) trips to site) regarding AV Systems operation to Owner- designated personnel. Schedule instruction time(s) with Owner to occur after completion of Final Tests and Adjustments. Coordinate with Owner in advance to schedule instruction time. Document date, time, and attendees of the training session and include documentation in Operation and Maintenance Manuals to serve as record of trained personnel.

3.10 SUPPORT DURING OWNER'S FIRST USE OF COMPLETED SYSTEM

A. Provide personnel familiar with design, installation, and operation of each system to be present at Owner's first use of each completed system (up to eight (8) hours total in a single session). During first use of each system, respond to Owner requests for troubleshooting, adjustments, and additional training. If no one contractor employee or representative can provide expertise in all aspects of the system, provide multiple personnel for the eight (8) hours per session as required. Schedule presence of personnel in advance with Owner. Should significant elements of the new system be operational prior to final completion, Owner may elect to schedule contractor presence for Owner function prior to final completion of system. Should Owner exercise this option, contractor presence will not be required at first use following final completion.

END OF SECTION

SECTION 275113
PAGING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. This document covers the general requirements for the installation of overhead paging systems with SIP interface.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections
   1. Div 26
   2. Section 270000 Communications
   3. Section 270526 Grounding and Bonding for Communications Systems
   4. Section 270528 Interior Pathways for Communications Systems
   5. Section 270543 Exterior Pathway for Communications Systems
   6. Section 270553 Identification for Communications Systems

1.03 CODES AND STANDARDS

A. Perform all work in strict accordance with the requirements and recommendations stated in the codes and standards except when requirements are exceeded by the contract documents.

B. The equipment, materials, and installation shall confirm to the latest version of all applicable codes, standards and regulations of authorities having jurisdiction including the following:
   1. American National Standards Institute (ANSI)
   2. American Society for Testing and Materials (ASTM)
   3. Alliance for Telecommunications Industry Solutions (ATIS)
   4. Federal Communications Commission (FCC)
   5. International Electrotechnical Commission (IEC)
   6. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
   7. International Organization for Standardization (ISO)
   8. International Organization of Standardization/International Electrotechnical Commission (ISO/IEC)
   9. National Cable Television Association (NCTA)
   10. National Electrical Code (NEC)
   11. National Electrical Manufacturers Association (NEMA)
   12. National Fire Protection Association (NFPA)
   13. National Institute Standards and Technology (NIST)
   14. Occupational Safety and Health Administration (OSHA)
   15. Telecommunications Industry Association (TIA)
   16. Comply with terms and conditions of Americans with Disabilities Act, especially regarding provisions for hearing impaired and wheelchair access in control areas.
   17. Execute work in accordance with best paging system installation practices, and applicable state and local codes.
   18. Owner’s Design Guidelines and Construction Standards

1.04 SUBMITTALS

A. General
   1. Refer to Division 1 and section 27 00 00.
   2. Submit in quantities, format and timetable as required by General Conditions.

B. Product Submittals

1. Contractor shall submit catalogue cut-sheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be handwritten and/or highlighted to indicate exact selection.
2. Contractor shall identify applicable specification section reference for each product performance for each component specified for approval prior to purchase and installation.
3. Minimum number of Sets: four (4) or one (1) electronic copy.
4. Provide a list of equipment (model and quantity) for paging system.
5. Timetable
    a. Submit within thirty (30) days after award of contract.
    b. Submit simultaneously with Shop Drawings.
    c. Allow minimum of ten (10) business days for review. All sets minus one
        1) will be returned with review comments. If a resubmit is required, resubmit total quantity of complete sets. If second resubmit is required, Contractor shall reimburse Owner for expenses incurred during additional review process.
    d. Review and approval of Product Data is required before equipment purchase and installation.

C. Shop Drawings
1. Shop drawings shall be submitted for review and approval before installation.
2. Minimum Number of Sets: four (4) or one (1) electronic copy.
3. Timetable
    a. Submit within thirty (30) days after award of contract.
    b. Submit simultaneously with Product Data Binders.
    c. Allow minimum of ten (10) business days for review. All sets minus one
        1) will be returned with review comments. If a resubmit is required, resubmit total quantity of complete sets. If second resubmit is required, Contract shall reimburse Owner for expenses incurred during additional review process.
4. Description:
    a. Shop Drawings shall be used for coordination between trades and updated as final record drawings.
    b. Bind all Shop Drawings together to form set. Loose drawings will not be accepted.
    c. Each drawing shall include: Project, Building, Location, Contractor Name, Architect, Paging Consultant, Date and Revision Number.
    d. Number and title each drawing in logical manner as a set.
    e. Include cover sheet with listing of all drawings included in bound set.
    f. Ensure that labeling on Shop Drawings match labeling on equipment.
    g. Minimum Scale:
        1) Floor Plans: 1/8 inch (3.18 mm) = 1 foot (30.48 cm).
        2) Rack Elevations: 1-½ inch = 1 foot (30.48 cm).
        3) Plate/Panel Details: 6 inches (152.4 mm) = 1 foot (30.48 cm).
        4) Loudspeaker Details: 1 inch (25.4 mm) = 1 foot (30.48 cm).
    h. Include as a minimum:
        1) Floor plans indicating locations of all paging devices, vertical risers, pull boxes, and exposed wiring. Include Device ID (SPKR, AMP, etc., as referenced in design contract documents), as appropriate for wall mounts, racks, floor boxes, face plates in walls, etc.
        2) Schematic diagram showing all primary and secondary devices, interconnectivity and signal flow.
        3) Plate details showing size, material, finish, connectors, engraving, etc.
        4) Speaker zoning
        5) Mounting detail drawings of loudspeakers, racks, and overhead equipment. Hire services of professional structural engineer, licensed by the appropriate governing authority, to review shop drawings, building structural drawings, and

any existing structures from which equipment is to be suspended. Include Structural Engineer's stamped report with shop drawing submittal. Report shall include:
(a) Itemization of items reviewed by the Structural Engineer.
(b) Confirmation that proposed methods of suspending equipment as shown on the shop drawings conform to required safety factors.
(c) Confirmation that building structure from which equipment is to be suspended will support equipment including required safety factors.

6) Rack elevations.
7) Complete schematic diagram. One-line diagram with detailed descriptions of product inputs and outputs is acceptable. Include terminal strip details and cable label information. If wiring diagram spans more than three (3) sheets, additionally provide simplified block diagram of entire system on one (1) sheet.
8) Electrical power wiring diagram. Include circuit, switching, and control details.
9) Wiring diagram of grounding and shielding scheme.
10) Drawings for custom-fabricated items (i.e., plates, panels, cables, and assemblies).
11) General construction drawings necessary for completion of work.

D. Operation and Maintenance Manuals
1. Minimum number of Sets: four (4).
2. Bind Operation and Maintenance Manuals using either GBC or 3-ring binders.
3. Format and Minimum Information below:
a. Section 1 - System Operation.
1) Introduction/overview to system components and their functions and locations. Include a brief listing of basic system functions.
2) Complete but simple system operating instructions to accomplish basic system functions, written for non-technical personnel.
3) Certificate indicating names of Owner personnel trained by Paging Contractor, date of training, name of Paging Contractor representative that provided training, and name of project.
b. Section 2 - System Documentation.
1) Simplified system one-line schematic diagram showing changes made during construction.
2) Complete inventory of system components including serial numbers. Identify location (equipment rack, over stage, stored in control room, etc.) of each component.
3) Cable and terminal strip documentation including cable numbers, functions, originating locations, terminating locations, and signal levels.
4) All Shop Drawings corrected to reflect as-built conditions.
5) Other data and drawings required during construction.
6) Initial Tests and Adjustments data.
7) Final Tests and Adjustments data.
8) Electronic file including all utilized manufacturer's software and saved copies of software configurations (configurations as established during Final Tests and Adjustments).
c. Section 3 - Manufacturer's Documentation.
1) For each equipment model at no additional costs to Owner, even if manufacturer does not include costs of such documentation with purchase of equipment item.
2) Manufacturer's Product Data.
3) Operating instructions.
4) Installation instructions.
5) Service information.

6) Schematic diagrams.
7) Replacement parts list.

d. Section 4 - Maintenance Information.
1) Preventive maintenance schedule letter clearly stating target dates of six month and end-of-warranty preventative maintenance inspections, and list of maintenance tasks performed.
2) Maintenance instructions including manufacturer's recommended maintenance, recommended maintenance schedule and information concerning proper inspection, testing, and replacement of components.
3) Troubleshooting information complete with instructions for procedures during equipment failure.

e. Section 5 - Warranty Information
1) 1) System warranty letter.

4. Provide a share file location that include the file with all material in Operation and Maintenance Manuals in PDF format except for copyrighted material.
5. Submit one (1) set of Operation and Maintenance Manuals at least ten (10) days before Final Tests and Adjustments procedures (minus data from Final Tests and Adjustments). This set will be reviewed by Owner and returned to Contractor. Re- submit after Final Tests and Adjustments and include data. NOTE: Do not schedule Final Tests and Adjustments or perform training of Owner personnel before submitting Operation and Maintenance Manual.
6. Submit remaining number of complete manuals as required by General Conditions within ten (10) days after return of reviewed set(s). Include Final Tests and Adjustment data, warranty period letter, and any other data not included in first submission.

E. Samples.
1. Request for Samples - Upon request, furnish samples (at no additional cost) to Owner and/or General Contractor of submitted items proposed as substitutes for specified items. Products will be reviewed to determine if proposed substitute items meet required function and quality.
2. Product Tests
a. Products submitted as samples may require testing by independent laboratory. Testing at expense of Contractor.
b. Obtain written approval of tested products before incorporating into system.

1.05 AS-BUILT DRAWINGS

A. Submit one electronic copy and one hard copy with project deliverables within three (3) weeks subsequent to substantial completion. Minimum Number of Sets: four (4) or one (1) electronic copy.

B. The As-Built drawings shall incorporate all changes made to the building identified in, but not limited to, addendum, change notices, site instructions or deviations resulting from site conditions.
1. Contractor shall clearly identify any resubmitted drawing sheets, documents or cut sheets either by using a color to highlight or cloud around resubmitted information.
2. Maintain drawing numbering or page/sheet scheme consistency as per previously issued Shop drawings/documents.

1.06 QUALITY ASSURANCE

A. Paging Contractor Qualifications.
1. Be an established Paging System Contractor, regularly engaged in furnishing and installing paging systems. NOTE: Electrical or general contracting firms responsible for completion of this work, but not meeting above requirement, shall employ services of approved Paging Contractor as subcontractor to perform work described herein.

2. Be experienced in installations of similar size and scope within last five (5) years. Submit list of four (4) (minimum) installed jobs of similar magnitude, completed within last five years. For verification, submit complete information, including project name, project address, contact person, daytime telephone number plus month and year of project completion. At Owner's request, accompany Owner or Owner's representative on visit to any or all example completed projects submitted.
3. Must have at least one permanent staff member who is formally trained in the installation and maintenance of each major product line offered. Must be trained and certified for installing and program Valcom paging system products.
4. Employ personnel (at all levels of work) experienced in projects of similar size and scope. Provide list of key personnel to be responsible for each of the following aspects of work: Project Management, Technical Documentation, Control System programming and Leadership of Field Work (one who is present for all field work). For each identified employee, indicate number of years employed by contractor, number of years experience in assigned responsibilities, and list of previously completed projects where similar responsibilities were required.
5. Project manager assigned to this project must have a minimum of five (5) years experience in installing and integrating paging systems of similar scale.

1.07 PRODUREMENT

A. Refer to 270000

B. Technology Implementation Plan shall be provided during the submittal review process.

PART 2 - PRODUCTS

2.01 GUIDELINES

A. Infrastructure Products - All conduits, basket tray/cable tray, pull boxes and associated parts required for infrastructure shall be installed by the electrical contractor unless specifically excluded in these specifications or drawings.

B. Performance - Regardless of completeness of descriptive paragraphs herein, each device shall meet its manufacturer's published specifications. Verify performance.

C. Contract Documents - Drawings and specifications are to be used in conjunction with one another and to supplement one another. In general the specifications determine the nature and quality of the materials, and the drawings establish the quantities, details, and give characteristics of performance that should be adhered to in the installation of the paging system components. If there is an apparent conflict between the drawings and specifications, the items with the greater quantity or quality shall be provided and installed. Clarification with the owner about these items shall be made prior to the ordering and installation.

D. Quantities - All quantities are indicated on paging drawings or in Part 2 Paging Products list. Confirm quantities on final Contract Documents. If Contract Documents do not include quantities necessary to deliver complete working system, provide notification of disparity, and install required quantity of devices for complete working system.

E. Small Parts - Systems are described in terms of major products. Even if not specifically mentioned, provide and install patch cables, connectors, hardware, converters, power supplies, labels, terminals, mounting accessories etc. necessary for complete and working system meeting design intent of specifications.

F. Condition - Provide and install products listed in this section in factory new condition, conforming to applicable provisions of American National Standards Institute.

G. Designations - Each major product item is given unique designation (such as SPKR 1 for speaker number 1). The product designations are unique in this section only and may be repeated in other specification sections.

2.02 PAGING PRODUCTS

A. VoIP Paging Interface
   1. Valcom V-9972-2

B. Network Page Zone Extender
   1. Valcom VE8004BR – four channel enhanced output module

C. Amplifier
   1. Crown CDi 4/300
   2. Or approved equal

D. Gypsum Ceiling Speaker
   1. Atlas SD72
   2. Or approved equal

E. Acoustical Ceiling Speaker
   1. Quam System 12/VC
   2. Or approved equal

F. Wall Mounted Horn Speaker
   1. Atlas AP30T
   2. Or approved equal

G. Surface Mounted Speaker
   1. Quam System 2
   2. Or approved equal

H. Equipment Cabinet
   1. CPI CUBE -iT
   2. Or approved equal

I. PDU with Sequencer
   1. Furman M-8S
   2. Or approved equal

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Guidelines
   1. Quality of Work - Perform labor to accepted industry standards and state and local codes to accomplish complete and working system.
   2. Material and Labor - Provide specified products and other incidental materials, appliances, tools, and transportation required for complete and functioning systems. Provide personnel to perform labor who are skilled in techniques and can demonstrate technical knowledge of paging infrastructure system installations.
   3. Provide a complete functioning sound system that’s been fully tested and properly balanced, configured, and equalized. Be of maximum assistance to the Owner during the warranty period of the system, to the degree that maximum Owner satisfaction is assured.
   4. Provide all audio circuits balanced and floating, except as noted in the Specifications or directed by the Consultant at the time of final equalization and testing. Shields of audio cables shall be grounded at one end only, at the outputs of the various equipment items in the system
   5. Route cables and wiring within equipment racks and cabinetry according to function, separating wires of different signal levels (microphone level, line level, amplifier output, 120VAC, intercom, control, etc.) by as much physical distance as possible. Neatly arrange and bundle all cables loosely with plastic cable ties. Cables and wires shall be continuous lengths without splices.

6. All system wire, except spare wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means. No unterminated wire ends will be accepted. Heat-shrink type tubing shall be used to insulate and dress the ends of all wire and cables. Include a separate tube for the ground or drain wire.
7. All cables in conduits shall be insulated from each other and from the conduit the entire length and shall not be spliced. All cables and wires are to be continuous lengths without splices.
8. Use suitable cable fittings and connectors.
9. Splice cable is not allowed, UON.
10. Label all wires in racks and console as to destination and purpose with permanent labels. Clearly and permanently label all controls and connections at the front and back of the rack, with permanent labels. Wall plates and custom panels shall be engraved and filled with contrasting paint, unless otherwise noted. All labeling shall be completed prior to final system inspection.
11. Documents at Job Site - Keep following documents at job site during entire construction period:
    a. Complete Specifications and Drawings.
    b. Approved Shop Drawings.
    c. Approved Product Data.
    d. Progress Set of Project Record Documents.
12. Mounting - Mount equipment and enclosures plumb and square. Ensure that permanently installed equipment is firmly and safely held in place. Design equipment supports to support loads imposed with project safety factor of five (5) or greater. For devices hung overhead, obtain review by Structural Engineer licensed by the appropriate governing authority prior to installation.
13. Provide adequate protective vandal guards for all devices located in areas subject to damage from activities or vandalization.
14. Dimension Verification - Verify dimensions and space requirements to assure that proper mounting, clearance, and maintenance access space is available for system components.
15. Clean-Up - Leave project clean each day. Place debris where designated by General Contractor. Debris includes but not limited to: solder splatter, cable ends, stripped insulation, spent crimp connectors, gypsum board and ceiling tile dust, and product wrappings and cartons. After completion of installation, thoroughly clean areas worked, including non-visible areas such as equipment rack interiors, rack top panels, and inside lockable floor and wall boxes.
16. Coordinate installation of paging infrastructure and equipment with other trades in order to follow project schedule.
17. Leave a three (3) foot service loop of cable at each termination and a ten (10) foot service loop at the MDF/IDF.
18. Support cables above accessible ceilings to keep them from resting on ceiling tiles. Use a ceiling suspension system at five (5) foot intervals.
19. Mounting Heights: Coordinate locations of outlet boxes to obtain mounting heights as indicated on drawings.
20. Ground and bond equipment and circuits in accordance with Division 26 and 27 requirements.
21. Maintain any licensing required by the appropriate governing authority to install and terminate low voltage systems.

B. Labeling
    1. Equipment Labels - Paging Contractor shall provide engraved lamicoid labels on front of wall-mounted equipment. Mount labels plumb and square. Include schematic reference design, item name, and system or area controlled by labeled component. On equipment interfaces, provide label for each input indicating which source is controlled by labeled

channel. Unless otherwise indicated, provide permanently-mounted black labels engraved with 1/8-inch white block characters. Handwritten, self-laminating, or embossed plastic (Dymo) labels are not acceptable. Provide labels for major equipment with two (2) lines (minimum) of engraving, coded as follows:
   a. Line 1: Generic name of device, such as AMPLIFIER.
   b. Line 2: Schematic designation of device, such as PAGING-AMP-1.
2. Control Labels - Paging Contractor shall provide engraved label over each user- operated control that describes the function or purpose of control. Provide label of proper size to fit available space.
3. Terminal Strip Labels – Paging Contractor shall label each terminal strip with unique identification code in addition to numerical label (Cinch MS series) for each terminal. Show terminal strip codes on system schematic drawings included with Project Record Documents.
4. Rear Equipment Labels - Paging Contractor shall provide adhesive label on rear of equipment where cables attach, to indicate designation of cable connected at each point.
5. Cable and Wire Labels - Label cables and wiring logically, legibly and permanently for easy identification. Labels on cables shall be adhesive strip type, covered with clear heat shrink tubing. Factory stamped heat shrink tubing may be used. Hand- written or self-laminating type labels are not acceptable.
6. Cable Label Codes and Locations - Label each cable with unique alpha-numeric code. Locate cable designation at start and end of each cable run, within three (3) inches of termination point. For cable runs that have intermediate splice points, label cable with same designation throughout, with additional suffix to indicate each segment of run. Provide cable designation codes to schematic drawings included with Project Record Documents and Operation and Maintenance Manuals.

C. Power and Grounding
   1. Power Coordination - Coordinate final connection of power and ground wiring to rack. Electrical contractor will provide power to paging systems. Before installation, verify load requirements for systems as accepted.
   2. Refer to Division 26.

D. Wiring
   1. All wiring shall be listed for the intended purpose. All interior wiring shall be in accordance with new construction guidelines.
   2. Run cable in ceiling plenums neatly parallel to building walls, supported every three feet to structure with plenum rated ties.
   3. All wiring shall be installed in raceways or plenum rated cables where routed in plenum ceiling areas.
   4. Accessibility - Ensure that wiring and connections are completely visible and labeled. Mount termination resistors, if required, on terminal strips, fully visible and not concealed within equipment or connectors.
   5. Loudspeaker Polarity - Connect loudspeakers electrically in phase, using same wire color for loudspeaker wiring throughout project.
   6. Physical Damage Prevention - Take necessary precautions to prevent physical damage to cables and equipment. Damaged cables or equipment will not be accepted. Separate, organize, and route cables to restrict channel crosstalk and feedback oscillation.

3.02 FIRESTOPPING

A. Refer to section 27 00 00.

3.03 STORAGE AND HANDLING

A. The contractor shall provide all necessary protection on the AC power feed and on all station lines leaving/entering the building.

B. The contractor shall note in his system drawings, the type of protection devices and all relative information.

C. Ensure that materials (especially electronic and electro-acoustic devices) are protected against physical, environmental, and electronic damage until final acceptance by Owner.

D. Schedule delivery to minimize delays in the project.

E. Provide storage protection against temperature and humidity extremes, theft, vandalism, physical damage, and environmental damage.

3.04 WARRANTY

A. Refer to Division 1.

B. Warranty - Submit letter providing warranty covering labor and materials supplied under this contract. Bind in Operation and Maintenance Manuals. Terms as described in General Conditions. Minimum terms as follows:
   1. System - Systems shall be free of manufacturing or installation defects for a minimum period of one (1) year from the date of final acceptance. Clearly designate begin and end dates of system warranty period.
   2. Parts and Labor - Provide parts and labor to repair defects in materials and workmanship during system warranty period.
   3. Response Time - Within system warranty period, provide initial on-site service response within one (1) business day of service call. Provide resolution to any system defects within 72 hours or within 48 hours of receipt of repaired or replaced product from manufacturer.
   4. Replacement Products - If any item must be removed for repair during system warranty period, provide replacement item of similar quality at no charge.
   5. Repair Limit - Do not repair any piece of equipment found defective during installation or system warranty period more than two (2) times. After second repair, replace defective item with similar approved item at no additional cost to Owner.
   6. Extended Manufacturer’s Warranties - Identify products with manufacturer’s warranties extending beyond one (1) year. Provide terms and conditions of such warranties.
   7. Service Personnel Information - Provide name(s) and telephone number(s) of service personnel to be contacted regarding repair and maintenance.

C. Extended Warranty - Provide cost to extend complete paging system warranty from one
   1. (1) year to three (3) years. Included a list of all provided services including maintenance schedules.

3.05 GROUDNING AND BONDING

A. Refer to Section 270526

3.06 PATHWAY

A. Refer to Section 270528

3.07 LABELLING

A. Refer to Section 270553

3.08 INITIAL TESTS

A. Purpose - These tests are to ensure that the paging system is installed and functioning as specified, and to ensure the system is ready for Final Tests and Adjustments (described later).

B. Testing Standards - Perform testing in accordance with ANSI standards.

C. Inspection - Verify prior to beginning actual tests and adjustments on systems:
   1. Proper grounding of all electronic components (through third prong of power connector or separate connection between component chassis and ground bus bar).
   2. Cables dressed, routed, and labeled, connected with proper polarity.
   3. Insulation and shrink tubing in place.

4. Dust, debris, solder splatter, etc. removed.
5. Proper frequency settings (or modules) at crossovers and controllers.
6. All equalizer bands and tone controls set for flat frequency response.
7. Survey temperatures of each piece of equipment after four (4) hours use (minimum). Note and report any hot equipment.

D. Electrical Power Quality - While all sound and paging system components are unplugged from electrical power outlets, Paging Contractor shall turn on power to outlets, and confirm proper voltages at each outlet across the following pairs of terminals: hot and neutral, hot and ground, and neutral and ground (zero volts across neutral and ground). Paging Contractor to document measurements.

E. General Function Tests - Test each piece of equipment to ensure that it performs its intended function. Include all portable equipment in tests. Intent of initial tests is to verify complete, functioning system before Final Tests and Adjustments. Correct problems found during initial testing before beginning Final Tests and Adjustments. Document whether all pieces performed intended functions; note any unresolved malfunctions.

F. Initial Tests and Adjustments Data - Submit written report of Initial Tests and Adjustments data upon completion to Owner. Include printed name(s) of technician(s) performing tests, date(s) and time(s) of tests, model and serial numbers of test equipment, results of each initial test, descriptions of problems encountered and their solutions, and statement that system is ready for Final Tests and Adjustments. Initial Tests and Adjustments Data to include signatures of technician(s) performing tests.

3.09 FINAL TESTS AND ADJUSTMENTS

A. Purpose - These tests are to be witnessed by the paging Consultant to determine if system is complete and functioning as designed and specified. Also, the paging Consultant will perform listening and viewing tests and witness adjustments of all images for optimum clarity.

B. Timetable - Coordinate with Owner, General Contractor, and paging Consultant to schedule Final Tests and Adjustments after submittal of Initial Tests and Adjustments data.

C. System and Site Conditions – Paging Consultant will witness Final Tests and Adjustments. Have systems fully functional and ready for observation and testing upon paging Consultant’s arrival. Coordinate with all trades for quiet conditions throughout the listening areas and for the duration of the test schedule. If upon paging Consultant’s arrival, systems do not meet criteria, site is not sufficiently quiet, or if Owner or paging Consultant is required to make additional trips to job site to witness additional testing or perform additional reviews of installed equipment, Contractor shall reimburse Owner for labor and expenses incurred by having incurred costs deducted from payments to contractor.

D. Test Labor - Provide technician familiar with this project’s paging systems and operation of test equipment to perform testing. Provide additional technician to assist in the tests and to perform troubleshooting, repairs, and adjustments. Include labor for these technicians to be present for one (1), eight (8)-hour day during Final Tests and Adjustments.

E. Tools - Provide standard hand tools including screwdrivers, pliers, wire strippers, nut drivers, soldering iron, and other tools appropriate for troubleshooting system problems.

F. Ladders and Scaffolds - Provide ladders and scaffolds to inspect/adjust loudspeakers and rigging points.

G. Verification of Initial Tests and Adjustments - Verify that Initial Tests and Adjustments have been performed and meet criteria. During Final Tests and Adjustments, the paging Consultant may require portions of the Initial Tests and Adjustments to be repeated. Repeat measurements as requested without claim for additional payment.

H. Installer shall perform thorough preliminary testing of the paging systems prior to the final inspection by the Consultant. All systems and subsystems shall be tested to ensure that they

are in proper working order and meet the performance specifications. Perform preliminary programming and setup of digital signal processors as necessary to conduct these tests.

I. The testing and equalization work shall be performed after the installation work has been completed, but prior to any use of the system. During the testing and equalization work, the Installer shall have on the job site one (1) competent technician who is familiar with the project, and who will be prepared to stay as long as his services are needed. It is estimated that approximately eight (8) hours will be required for this work

J. The process of equalizing and testing the system may necessitate moving and adjusting certain loudspeakers. Adjustments shall be performed without claim for additional payment.

K. Coordinate as necessary to ensure a totally quiet room during the sound reinforcement systems testing and balancing period.

L. Prior to requesting systems testing, verify the following:
   1. All systems are in first-class working condition and free of short circuits, ground loops, parasitic oscillations, excessive system noise beyond published.
   2. All specified equipment, including loose equipment, is on the job site for proper accounting.
   3. All loudspeaker circuits have been tested, are connected to the proper crossover frequency, and are in perfect working order. Furnish impedance measurements of each circuit in PDF format prior to final tests.
   4. All equipment controls shall be labeled, even if unused. If permanent labels cannot be furnished prior to system inspection, temporarily label every control on the front and in the rear of the racks as to its function with write-on tape. Supply printer labels or markers suitable for permanently indicating knob settings after equalization is performed.
   5. Operation manuals for every equipment item furnished are on hand at the job site.
   6. Installer shall provide all signal processing software loaded on a portable PC and ready for use at time of testing. Installer shall provide a calibrated RTA and microphone, and pink noise generator at time of testing.

M. Should the performance testing show that the Installer has not properly completed the systems, the Installer shall make all necessary corrections or adjustments and a second demonstration shall be arranged at the Installer's expense.

N. The final acceptance of the system by the Owner will be based upon the report of the Consultant following inspection, testing, and demonstration. A list of items in need of completion or correction shall be generated by the Consultant, which must be corrected by the Installer before final acceptance will be granted.

3.10 SOUND SYSTEM PERFORMANCE

A. After equalization and testing, the sound system shall meet or exceed the following specifications:
   1. System shall be free of short circuits, ground loops, parasitic oscillation, excessive system noise, hum, RF interference, and instability of any form.
   2. Minimum SPL with band-limited pink noise input to the system in the targeted space shall be 95 dB before audible distortion occurs.
   3. Seat-to-seat variation in SPL at 4kHz octave band pink noise shall be within a tolerance of plus or minus 3dB SPL.
   4. Acoustic response of the system shall be plus or minus 1.5dB along a line which is flat from 50 Hz to 4000 Hz and which rolls off at 1dB per octave to 16kHz.

B. The following tests and adjustments shall be performed by the Contractor.. Make all necessary corrections to bring systems into specification compliance. Record the results of these tests in project record drawings. Submit written results of tests to Architect and Engineer prior to scheduled equalization and final inspection date.

1. Measure and record impedance of each speaker line at frequency of 1,000 Hz, with loudspeakers connected to their respective lines.
2. Measure and record overall system hum and noise level of each input channel with controls set so that -50 dBm microphone input or +4 dBm input would drive the system to full amplifier output. Terminate inputs with resistor (150 to 600 ohms) and disconnect power to noise generator for this test.
3. Adjust the gain of each active device to provide both optimum signal - to noise ratio, and at least 10 dB headroom at each active device. Observe the output of each active device with an oscilloscope of 5 MHZ bandwidth and verify visually that the signal required for full amplifier output is free of overload, clipping, parasitics, and radio frequency components. Adjust gain structure of all active components and record the input and output signal levels of all active components and record the input and output signal levels of all active components in both dBm and volts, during normal program levels.
4. Measure and record system electrical frequency response for each input channel through power amplifier. Required is flat response with permissible deviation of +/- 1 dB within the range of 30 Hz to 16 kHz.
5. Check system to assure freedom from oscillations or stray RF pickup. Check inputs with no signal and with typical program material driving system to full output Detect unwanted signals on Oscilloscope at termination.
6. Check phasing of loudspeakers by applying constant power per octave (pink) noise to system and walking through the transition areas of coverage from one loudspeaker to the next. Transition should be smooth with no apparent shift in source from one speaker to the next. Apply sine wave sweet signal to each loudspeaker system sweeping from 50 Hz to 5,000 Hz and at a level of 10 Db below full amplifier output, and listen for rattle or objectionable noises Correct if apparent.
7. Achieve uniform distribution of sound from each loudspeaker (with bleachers in their extended position in gymnasium where applicable). Drive system with broadband, constant power per octave (pink) noise, and measure the SPL using a sound level meter incorporating an octave-band filter centered at 4 kHz. Adjust noise level until the meter readings are between 75 and 80 dB. Use a sound level meter filter that meets ANSI S1 4-1971 Type 2 and ANSI S1 11-1971 standards set for slow meter damping. Take all readings at seated ear height. Adjust speaker as necessary to achieve +/-3 dB over entire area covered by this system.

3.11 FINAL ACCEPTANCE BY OWNER

A. Certificate - Submit Certificate of Final Acceptance form signed by Owner verifying complete installation and proper operation of systems upon fulfillment of all requirements and upon recommendation by Owner.

B. General Adjustments - Adjust, balance, and align equipment for optimum quality, meeting manufacturers published specifications.

C. Input/Output Jack Demonstration - Demonstrate proper performance and phase of each system input and output jack (all audio input and output jacks) as received at paging and network systems.

D. Inventory - Inventory all installed and portable equipment for correct quantities.

E. Functional Demonstration - Demonstrate operation of each function of each major piece of equipment.

F. Other Tests - Perform any other tests on any part of the paging system as requested by Owner.

G. Final Equipment Settings - Record final settings of all equalizer bands, tone controls, filters, delays, limiters, etc., including those established through computer software settings. Include descriptions of settings (including software settings) in Operation and Maintenance Manual. Include software copy of configuration file(s) in Operation and Maintenance Manual.

H. Security Inspection - Inspect equipment for security from tampering (covers, shaft-locks, etc.).

I. Review of Labels - Review installed labels on cables, equipment, controls, and terminal strips.

3.12 OWNER TRAINING

A. Provide Owner training as described in General Conditions. As a minimum, provide eight
   1. (8) hours instruction (within two (2) trips to site) regarding Paging Systems operation to Owner-designated personnel. Schedule instruction time(s) with Owner to occur after completion of Final Tests and Adjustments. Coordinate with Owner in advance to schedule instruction time. Document date, time, and attendees of the training session and include documentation in Operation and Maintenance Manuals to serve as record of trained personnel.

3.13 SUPPORT DURING OWNER'S FIRST USE OF COMPLETED SYSTEM

A. Provide personnel familiar with design, installation, and operation of each system to be present at Owner's first use of each completed system (up to eight (8) hours total in a single session). During first use of each system, respond to Owner requests for troubleshooting, adjustments, and additional training. If no one contractor employee or representative can provide expertise in all aspects of the system, provide multiple personnel for the eight (8) hours per session as required. Schedule presence of personnel in advance with Owner. Should significant elements of the new system be operational prior to final completion, Owner may elect to schedule contractor presence for Owner function prior to final completion of system. Should Owner exercise this option, contractor presence will not be required at first use following final completion.

3.14 PROJECT CLOSEOUT

A. Refer to section 270000

END OF SECTION

SECTION 275319
EMERGENCY RESPONDER RADIO COMMUNICATION SYSTEM

GENERAL

1.01 SUMMARY

A. Section Includes: Radio distribution system to support Emergency Responder Radio Communication System, Emergency Communications Systems, and multiple first responder Radio Systems for Emergency Response wireless services, primarily in-building – herein “System”.

1.02 BASE BID WORK

A. The work of this section includes furnishing materials, installation, and coordination through the General Contractor with other trades for a complete, operational, and balanced Emergency Responder Radio Communication System. Provide a complete turn-key system that supports frequencies and services throughout the coverage spaces specified herein. Furnish materials, accessories, fasteners, etc., and the labor and associated services necessary for a complete and operational System, whether expressly stated or not. Coordinate the work of this section with other trades through the General Contractor.

B. The work of this section includes the following:
   1. Provide Project management services
   2. Validate current and planned future emergency services and associated frequencies
   3. Coordinate antenna placement and mounting coordination with the General Contractor and affected trades; mounting confirmation with both the architect and the Owner
   4. Conduct initial on-site discovery survey
   5. Provided detailed system design and drawings
   6. Review of pathways and enclosures for NFPA 1221 compliance
   7. Provide coordination with the overall construction team and usage of provided pathways
   8. Provide installation and system balancing
   9. Provide coordination with the overall construction team and usage of pathways provided by others
   10. Provide NEMA 4-type waterproof cabinet
   11. Include patch cords (to connect System equipment)
   12. Manage FCC licensing and FCC registration, including Part 90 requirements
   13. Provide system acceptance testing and turn over to Owner
   14. Provide a warranty
   15. Provide maintenance and support services

C. Power Service:
   1. Coordinate with the electrical contractor the power provisions required for the System. The ERRCS contractor is solely responsible to ensure proper electrical power service.
   2. Provide power backup battery to support the System with a runtime of 12 hours, minimum. If the project includes a standby power source (e.g., a generator) that provides backup power for at least 12 hours, then provide backup battery with a runtime of 10 minutes, minimum. If the project does not include a standby power source, then provide power backup battery with a runtime of 12 hours, minimum

D. Coordination Requirements:
   1. Ceiling Types: Understand every ceiling type and its interaction with the System. For example, some ceiling types may impede RF signals and, subsequently, performance.
   2. Mounting Details: Coordinate antenna mounting and the resulting RF performance. It may be preferred that antennas be mounted above or below ceiling grid. Coordinate with both the architect and the Owner. Adjust as approved to optimize performance.

3. Pathways: Coordinate placement of System cables within pathways provided by others. Only place System cables into pathways provided by others with their permission.

1.03 WORK COVERED UNDER OTHER SECTIONS

A. Electrical power – raceways, junction boxes, circuits, branch wiring, and receptacles

B. Pathways – backbone conduits, primary pathways (such as cable trays), conduits, sleeves

C. Telecommunications Rooms – equipment support (racks/frames), power service, cooling, and grounding

1.04 RELATED SECTIONS

A. Comply with the Related Sections requirements of the following:
1. Div 01
2. Div 26
3. Section 270000 Communications
4. Section 270526 Grounding and Bonding for Communications Systems
5. Section 270528 Interior Pathways for Communications Systems
6. Section 270543 Exterior Pathway for Communications Systems
7. Section 270553 Identification for Communications Systems
8. Section 283100 Fire Detection and Alarms System

1.05 REFERENCES

A. Comply with the References requirements of related sections (above).

B. In addition to the codes and standards listed in section 270000, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:

C. Committee of the Federal Register (CFR) Title 47 “Telecommunication”, Chapter I “Federal Communications Commission” (FCC) Regulations:

D. Part 24, “Personal Communications Services”

E. Part 27, “Miscellaneous Wireless Communications Services”

F. Part 95, “Personal Radio Services”

G. NFPA 72 “National Fire Alarm and Signal Code Regulations”

H. Chapter 24, “Emergency Communication Systems (ECS)”

I. Pathway Survivability
a. 1) Two-Way Radio Communication Enhancement System

J. NFPA 1221 “Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems”

K. Houston Building and Fire Codes Sections 914 and 510.

L. Harris County Standards

M. Refer to Predictive Survey Design Report for coverage analysis.

1.06 DEFINITIONS

A. Definitions as described in section 270000 shall apply to this section.

B. In addition to those Definitions of section 270000, the following list of terms as used in this specification defined as follows:

C. “AHJ”: Authority Having Jurisdiction

D. “BDA”: Bi-Directional Amplifier

E. “BOM”: Bill-of-Material

F. “BTS”: Base Transceiver Station

G. “C/N”: Carrier-to-Noise Ratio
H. “DAQ”: Delivered Audio Quality
I. “DMR”: Digital Mobile Radio
J. “DAS”: Distributed Antenna system (synonymous with in-building antenna system)
K. “ECS”: Emergency Communication Systems (referenced within NFPA 72)
L. “ERRCS”: Emergency Responder Radio Communication System (referenced within NFPA 1221)
M. “FCC”: Federal Communications Commission
N. “Feeder”: Horizontal cable runs to antennas
O. “GROL”: General Radio Operator’s License
P. “GUI”: Graphical User Interface
Q. “iDEN”: Integrated digital enhanced network
R. “LMR”: Land Mobile Radio
S. “NFPA”: National Fire Protection Association
T. “PCS”: Personal communications service
U. “PIM”: Passive Intermodulation
V. “PSN”: Public Safety Network
W. “PSRS”: Public Safety Radio System (referenced within NFPA 72)
X. “RF”: Radio Frequency
Y. “Riser”: Vertical cable runs to remote amplifiers and horizontal / feeder branches
Z. “RSSI”: Received Signal Strength Indication
AA. “SMR”: Specialized Mobile Radio (synonymous with trunked radio or public access mobile radio)
BB. “SOW”: Statement of Work

1.07 SYSTEM DESCRIPTION

A. The System, or “ERRCS”, shall reliably distribute RF signals for multiple first responder/emergency response wireless services throughout the specified frequency ranges and the specified coverage areas. The System shall be implemented based on proven technology that can seamlessly integrate with the rapid evolution of wireless technologies and business applications. The System shall be flexible and shall easily accommodate additional wireless services within the System’s frequency bands without requiring significant upgrades or system modifications.
B. The System shall include subsystems, equipment, components, transmission media, connection/ termination apparatus, etc., necessary for a complete operating system as described herein.
C. The System shall continuously distribute public safety radio signal throughout the building for 24 hours, minimum, during an event such as loss of utility power, as required per NFPA 1221. Therefore, the System requires continuous power with a runtime of 24 hours, minimum. The System requires dedicated circuit(s) to the equipment primary power source(s).
D. The active equipment and battery systems shall be electrically supervised and monitored by a supervisory service, or when approved the AHJ, shall sound an audible signal at a constantly attended location, as required 510.4.2.4 #3.
E. The System requires riser and feeder pathway survivability level 2 per NFPA 72 and 1221.
F. Riser and feeder cables shall be plenum rated.

G. Feeder cables shall be connected to riser cables via either coaxial couplers/splitters or to fiber remotes.

H. Riser cables shall route through a 2-hour rated assembly.

I. Connections between riser and feeder cables shall be made within the 2-hour rated assembly, and passage of feeder cables into/out of 2-hour rated assemblies shall be fire- stopped to 2-hour ratings.

J. The System shall have lightning protection.

1.08 DESIGN CRITERIA

A. Frequency Range: The System shall support all the following frequencies.

B. Contact Owner – Radio Communications Services and Harris County Radio Network Operation Center (RNOC) for specific frequencies required at specific project locations.

C. The System shall distribute RF coverage throughout interior spaces.

D. The System shall support public safety (including “First Responder”) wireless services and technologies, including the following:
   1. Local police department
   2. City police department
   3. County sheriff
   4. Fire department

E. The System shall have the capability for separate control over each service to allow adjustment and of control power levels without disturbing other services/operators.

F. The System shall support multiple services in a modular architecture so services can be added or removed without requiring new infrastructure, without readjustment of signal power levels, and disturbing existing services.

G. The System shall not impede any management features or functionality of any attached network and/or device management system.

H. The System shall allow for proactive management and end-to-end alarming of active electronics.

I. The System shall provide fault management information.

J. System Supervision
   1. The System’s electronic supervision shall monitor, at a minimum, the following:
      a. Loss of normal AC power
      b. Failure of UPS/battery charger
      c. Low-battery status
      d. Signal booster failure/failure
      e. Donor antenna failure
      f. Active RF emitting device malfunction/failure
      g. Distribution antenna failure
   2. The System shall audibly annunciate alarms generated by the supervision.
   3. The System shall have a separate dedicated supervision panel located near the building’s fire alarm control panel.

K. The Owner prefers that the System’s antennas be mounted above ceiling grids. Coordinate the RF design and the antenna placement, and mounting with both the architect and the Owner throughout the project.

L. The System’s transmission media can take many forms, from traditional off-air repeater or BTS to a tethered architecture consisting of a hybrid fiber base solution. The System shall extend the first responder / emergency services frequencies from the headend by interfacing to either a passive or active ERRCS that is deployed in each of the building structures.

M. The System shall interface with the Fire Alarm System, compliant with NFPA 1221.

N. The System shall monitor the power source, system status, and other critical aspects to the System's overall operation and shall provide alarming annunciation – all as required by the AHJ.

O. The System shall distribute public safety channels with -95 dBm (or stronger) signal strength (RSSI) throughout 95% of occupied building spaces and 99% in critical areas as defined in NFPA 1221 and IFC or as required by local ordinance and agencies, including local and city police, county sheriff, and fire departments. Confirm with the AHJ, Owner, and additional authorities' frequencies that will be in use at the time of facility opening.

P. The System shall have at a minimum 20 dB isolation between a donor antenna and all inside antenna with as defined in NFPA 1221 or as required by local ordinance and agencies, including local and city police, county sheriff, and fire departments. Confirm with the AHJ, Owner, and additional authorities' frequencies that will be in use at the time of facility opening.

Q. The sound quality shall meet or exceed DAQ 3.0 ("Speech understandable with slight effort; requires occasional repetition due to noise or distortion") as defined in NFPA 1221.

R. The System and the associated wireless devices shall comply with the FCC and regional regulatory authorities' emission rules for wireless devices.
   1. Refer to: FCC advisory: "A Local Government Official's Guide to Transmitting Antenna RF Emission Safety Rules, Procedures, and Practical Guidance", FCC's OET Bulletin 65, FCC Rule 47-part 17 and (ANSI/IEEE C95.1-1992) Hazardous Emission document.

S. New Construction: A pretest shall be conducted to determine whether the building has the radio coverage required by code, or a radio signal enhancing system is needed. When a
   1. DBA system is needed, ERRC plans must be submitted for our review as per PART 3 below. Prior to issuing the Certificate of Occupancy (CO) or approving the final inspection, facilities not otherwise exempted by PART 2 below, shall be tested by a registered ERRC third-party special inspector using appropriately trained personnel. With prior approval from the building official and the fire code official, a wired communication system in accordance with Section 907.2.13.2 may be permitted to be installed or maintained for new construction in lieu of an approved radio coverage system.

1.09 SUBMITTALS

A. Comply with Submittal procedural, quantity, and format requirements of section 270000.

B. Submittal Requirements with the Bid:
   1. Statement of Work that describes the entire proposed scope
   2. A brief description of the intended system, including manufacturer and major equipment.
   3. A certificate from the manufacturer of the equipment to be installed stating that the ERRCS installer is trained and qualified on the equipment.

1.10 SUBMITTAL REQUIREMENTS PRIOR TO START OF CONSTRUCTION:

A. Initial on-site discovery survey report following NFPA 1221 Annex A testing guidelines

B. Product data submittal

C. Shop Drawings Submittal – Include the following in the shop drawing submittal:

D. System or functional block/line diagrams

E. Plans showing the location of the following components: Donor antenna, indoor antennas, couplers, splitters, cable routes, remotes/BDAs, and head-end equipment.

F. Mounting details, and other installation information – identify construction elements that would affect the system's performance (such as metallic ceiling materials).

G. Coverage plans, showing the design RF coverage (signal strength) for each frequency band described in section 1.04 (listed above) using iBwave or another industry acceptable RF modeling tool and provide the following:
    a. Optimized iBwave model with outdoor discovery survey collected data
    b. Signal strength RSSI, with color coded compliance legend

H. Wall and rack elevations, showing equipment layout, space requirements and integration with other systems (outside the scope of the ERRCS)

I. Installation details for antenna mounting, specialty cable hangers, and other components unique to the system, and other information that depicts the intended installation

J. Compliance to permitting agency requirements

1.11 SUBMITTAL REQUIREMENTS PRIOR TO ACCEPTANCE TESTING:

A. Current calibration and test data on the test equipment to be used in the system commissioning.

B. Acceptance Test Plan (ATP): This submittal shall describe in detail the procedure for testing the System's performance and balancing the System's signal strength, including a description of the test data (or an example of the test report). The procedures and results shall demonstrate the desired services have been successfully deployed and tested. The ERRCS must be deployed with the AHJ criteria and approval.

1.12 SUBMITTAL REQUIREMENTS AT CLOSE OUT:

A. As-Built Drawings, including
    1. Donor antenna, grounding and lightning protection details
    2. Cable routing, splitters, couplers and coverage antenna locations
    3. Active component locations, layout and configuration

B. Test Reports
    1. AHJ: Submit a confirming letter accepting the ATP results
    2. Cable test results – includes every cable segment
    3. Validation survey report

C. Operations and Maintenance Manual (refer to section 270000 for contents)

D. Warranty Documents
    1. Submit Contractor's System warranty, including procedures and contact information for service calls under warranty.
    2. Submit Manufacturer's Extended warranty, including procedures and contact information for service calls under warranty.

E. Integration of components and pathways into the Building Information Model (BIM)

1.13 QUALITY ASSURANCE

A. Comply with Quality Assurance requirements of section 270000.

B. Comply with manufacturers' specifications.

1.14 ERRC DESIGNER REQUIREMENTS

A. The code provisions of Section 510.4.2.9 IFC (2015) require the ERRC system designer to be:
    1. A Texas Professional Engineer with appropriate training (Plans shall be sealed, signed and dated.)

1.15 ERRC SYSTEM INSTALLATION AND TESTING

A. The ERRC system may be installed, and special inspection testing completed by:
    1. A Texas Professional Engineer with appropriate training, or
    2. A valid FCC Licensed General Radio Telephone Operator registered as an ERRC Special Inspector; with in-building emergency radio system certification issued by a nationally

recognized organization, school or the emergency radio system manufacturer of the equipment being installed.

1.16 DELIVERY, STORAGE, AND HANDLING

A. Comply with Delivery, Storage, and Handling requirements of section 270000.

1.17 WARRANTY

A. Comply with the Warranty requirements described in section 270000. Warrant the System to perform as described within this section, including workmanship, components, electronics, and signal coverage – herein “warranty period”.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Comba
B. JMA Wireless
C. SOLiD Technologies
D. SureCall
E. Or equal

2.02 SUBSTITUTIONS

A. Comply with the Substitution requirements of section 270000.

2.03 ANNUNCIATOR

A. Displays status of BDA, Donor Antenna, AC Power, Battery Capacity, Battery Charger, and System Status.
B. Includes a form C relay for interface with fire alarm system
C. NEMA-4 enclosure
D. Internal battery back-up
E. Manufacturer, or equal:
    1. DASalert #1221

2.04 TEST EQUIPMENT

A. Specifications
    1. Accuracy: ±1 dB (across basic RF input power range)
    2. Dynamic range: -120 dBm to -20 dBm at 30 kHz
    3. Frequency range: 150 MHz to 900MHz
    4. Technologies: LMR, and P25
    5. Connection: Bluetooth or USB to Windows laptop or Android tablet
    6. Power: Hot-swappable batteries
B. Manufacturers, or equal:
    1. Anritsu MS2720T spectrum analyzer
    2. PCTEL – IBflex
    3. Keysight – Nemo
    4. FalconSmart – Falcon Kitt

PART 3 - EXECUTION

3.01 GENERAL

A. REFERENCE STANDARDS
    1. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.

2. NFPA 1221 - Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems; 2019, with Amendment (2021).
3. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2021d.

B. Comply with the Execution requirements of section 270000.

C. Comply with manufacturers specifications.

3.02 PRE-INSTALLATION AND COORDINATION

A. Prior to design, conduct an on-site discovery survey within the building and outside the building of existing signal strength of all required frequency bands identified in 1.04 “System Description” above. The onsite survey will consist of the following:

B. Locations
1. Record signal strengths of required frequency bands present at the optimal location for a donor antenna.
2. Each floor of the building shall be divided into a grid of equal test areas.
   a. Floors with less than or equal to 128,000 sq-ft use a grid of 20 approximately equal test areas between 20 to 80 ft each.
   b. Floors with greater than 128,000 sq-ft use equal grids that have a maximum of 80 feet (2438.4 cm)
3. Downlink received signal level measurements will be recorded in the coverage area using a continuous wave test signal. Measurements will be collected using a spectrum analyzer and a dipole antenna.
4. A test location approximately in the center of teach test area shall be selected for the test. Once the location has been selected, the location shall represent the entire test area.

C. Equipment Requirements
1. Spectrum analyzer with unity gain (0dB, frequency specific) dipole receive antenna must be approved by the project engineer.
2. Stabilize the test equipment in the test environment for a minimum of thirty minutes prior to calibration. For example, temperature variations can void the calibration.
3. Use a spectrum analyzer to capture and present signal strength. It is preferable to present signal strength as a graphical “heatmap”.
4. Save screen shots during testing that show frequency span +/- 20 MHz relative to the center / measured frequency.

D. Documentation
1. Documentation shall include the exact location of measurement marked on the grid print.
2. Screen shots must be taken in all designated grid spaces. If more than one reading is saved per grid zone, saved results shall be distinguished from one another using Grid# “A”, Grid# “B” etc.
3. Submit the testing results to the project engineer for analysis and reporting.

E. Detailed System Design:
1. Use the requirements of this section to complete the detailed design of the System. Design shall include computer RF modeling and site surveys.
2. The detailed design shall deliver the pre-construction submittals, including iterations for the Owner’s review and sign-off.
3. Design RF signal levels to sub-room precision for rooms within the defined coverage areas. Obtain compatible drawings from architect. If drawings are within BIM, then modify the BIM model for use in wireless modeling including the creation of 2-D floor plans, RCP plans and elevations.

F. Coordinate RF rebroadcasting agreements with AHJ.

G. Represent the Owner during negotiations with the AHJ to obtain their approval.

3.03 EXAMINATION AND PREPARATION

A. Examine equipment rooms, pathways, power service, NFPA 72 and NFPA 1221 compliance, and other aspects for completeness, the compatibility with the work of this section, and the readiness for connections with the work of this section.

B. Confirm that the fire-alarm system's annunciator is ready for connection to the System.

3.04 PRE-INSTALLATION AND COORDINATION

A. Coordinate RF rebroadcasting agreements with AHJ.

B. Represent the Owner during negotiations with the AHJ to obtain their approval.

3.05 EXAMINATION AND PREPARATION

A. Examine equipment rooms, pathways, power service, NFPA 72 and NFPA 1221 compliance, and other aspects for completeness, the compatibility with the work of this section, and the readiness for connections with the work of this section.

B. Confirm that the fire-alarm system's annunciator is ready for connection to the System.

3.06 PROJECT MANAGEMENT SERVICES:

A. Assign project manager, a single-point-of-contact, to this project with overall responsibility for communications and ultimate delivery of contracted materials, installation, performance criteria, and services. This PM shall be responsible for interfacing with the Owner, AHJ, the General Contractor, and their own subcontractors.

B. Represent the Construction Team to coordinate on-site construction activities with the General Contractor.

C. Close out the project with the Owner.

3.07 INSTALLATION

A. Coordinate the installation and schedule with the Owner, General Contractor and electrical contractor prior to the start of installation activities. Once the Owner and General Contractor have accepted the coordination and schedule, proceed with installation.

B. Coordinate the location of and power service to a NEMA 4 type cabinet. Anchor the cabinet to the building structure per the project's approved methods.

C. Install active signal components and battery systems (used for emergency power) in a NEMA 4 type cabinet.

D. Meet with the Owner to discuss their needs for monitoring the System. Set up the electronic supervisory system (used to monitor signal booster components, emergency power and battery systems) per the Owner's requirements.

3.08 MAST AND DONOR ANTENNA INSTALLATION

A. Coordinate mast location with adjacent equipment so that other constructions do not obstruct the signal, and that the mast will not physically interfere with other roof-top equipment.
   1. Where a permanently installed mast location isn't available in order to guarantee adequate signal strength, use of a weighted antenna mast system may be used.
   2. For weighted antenna masts, verify with the structural engineer that the weight does not exceed the roof's limits, and, confirm wind-load requirements with the structural engineer.

B. Weather-seal penetrations.

C. Bond lighting arrestors to grounding system.

D. Secure cabling extending from weather-heads/penetrations to antenna mast in such a manner that the cable can not be tripped over, or otherwise damaged by personnel servicing roof-top equipment.

3.09 INDOOR ANTENNA INSTALLATION

A. Mount according to manufacturers' recommendations.

B. Mount at locations identified within ERRCS design drawings. Avoid mounting locations as follows:
   1. Adjacent to metal materials
   2. Adjacent to RF signal sources

C. Cable paths to antennas shall match ERRCS design drawings.

D. Deviation of installation details and/or locations must be coordinated with ERRCS design engineer.

E. Change default passwords in accordance with the Owner's direction.

F. Install latest software versions, firmware, and security patches.

G. Disable unused communication ports, protocols and access accounts.

H. Test the following during installation: Return Loss (RL) and Distance to Fault (DTF)

I. System Balancing: Balance system component (e.g., antenna) signal strength to the device signal levels.

J. Alert the AHJ prior to bringing the system operational.

K. Manage FCC License: Acting as a representative of the Owner, obtain required licenses for operation under FCC Regulations.

L. Do not install amplification systems capable of operating on frequencies licensed to any public safety agency by the FCC without prior coordination and approval by the AHJ.

3.10 LABELING

A. Refer to 27 05 53

3.11 GENERAL REQUIREMENTS

A. Label equipment, components, and cables.

B. Labels shall be permanent.

C. Text shall be machine-generated; handwritten labels will not be accepted.

D. Labeling, label colors, and identifier assignment shall conform to the TIA-606 standard. Coordinate labeling and identifier assignment with the Engineer or Owner.

E. Submit a labeling plan for approval prior to labeling work

3.12 EQUIPMENT LABELING

A. Affix labels to equipment (such as fiber remote units) such that they will be clearly visible.

3.13 CABLE LABELING

A. Affix label as close as practical to each end of each cable.

B. Cable labels shall fully wrap around cable jackets resulting in a self-laminating result.

3.14 ANTENNA LABELING

A. Affix labels to antennas such that they will be clearly visible.

3.15 ACCEPTANCE TESTING / VALIDATION SURVEY

A. Complete acceptance testing in accordance with the approved Acceptance Test Plan (ATP). Only a qualified person or persons familiar with ERRCS and associated data collection tools shall test the System.

B. Perform an on-site survey to validate RF coverage (signal strength) throughout coverage areas (listed in Part 1) using approved test equipment.

3.16 TESTING PROCEDURE

A. Verify that remote units for the area under test are on.

B. Record signal strengths of required frequency bands present at the donor antenna.

C. Each floor of the building shall be divided into a grid of equal test areas
   1. Floors with less than or equal to 128,000 sq-ft use a grid of 20 approximately equal test areas between 20 to 80 ft each
   2. Floors with greater than 128,000 sq-ft use equal grids that have a maximum of 80 feet (2438.4 cm) It is recommended that the floor be subdivided into sectors each having an area less than or equal to 128,000 sq-ft, and each sector be tested individually with 20 ft grid cells in each sector.

D. A test location approximately in the center of teach test area shall be selected for the test. Once the location has been selected, the location shall represent the entire test area.

E. Downlink received signal level will be recorded in the coverage area using a continuous wave test signal. Measurements will be collected using a spectrum analyzer and a dipole antenna.

F. Signal strength and link spectrum: Must meet or exceed all critical areas and less than nine nonadjacent and/or six adjacent cell failures.

G. DAQ: Must meet or exceed all critical areas and not more than two non-adjacent grid cells failures. If two adjacent areas fail the DAQ test then grid should be halved and retested with no more than eight nonadjacent and/or five adjacent cell failures

3.17 EQUIPMENT REQUIREMENTS

A. Testing equipment must be calibrated within the past 12 months.

B. Allow test equipment to stabilize in the test environment prior to calibration for a minimum of thirty minutes. Changes in temperature can void the calibration.

C. Verify that all remote units for the area under test are ON.

D. Test frequency and power measurements shall be time stamped.

E. Use a spectrum analyzer to capture and present signal strength, preapproved by the project engineer.
   1. Verify the spectrum analyzer is set to unity gain (0dB, frequency specific) so that the combination of analyzer and its antenna do not artificially increase measurement results.
   2. Present signal strength as a graphical “heatmap”.

F. Site walk screen shots shall be saved with frequency span +/- 20 MHz relative to the center
   1. / measured frequency.

3.18 DOCUMENTATION

A. Exact location of measurement must be marked on the grid print.

B. Screen shots must be taken in all designated grid spaces. If more than one reading is saved per grid zone, saved results shall be distinguished from one another using Grid# “A”, Grid# “B”, etc.

C. Produce a validation survey report documenting the results including heat maps of the following:
   1. Signal strength (RSSI)

D. Report testing results to the project engineer for analysis.

3.19 FINAL INSPECTION

A. Participate in a punch walk with thee engineer to demonstrate that the work complies with the requirements of this section.

B. Submit Certificate of Compliance with manufacturers specifications.

C. Submit final testing documentation to and obtain acceptance from the AHJ. Include these documents in the as-builts.

3.20 TURNOVER AND TRAINING

A. Pre-emptive Maintenance Minimum Requirements: Perform the following just prior to closeout.

B. Clean filters, vents, and equipment components that may accumulate dust and dirt.

C. Organize and manage cables and cords that have been placed.

D. Update firmware with latest versions.

E. Document and photograph any conditions that may affect the continuing function and long-term operation of the System and report to Owner.

F. Present the completed system and wireless services to the Owner, including functionality, features, ongoing maintenance, and warranty procedures. Demonstrate to Owner and engineer, system operation, including signal strength at selected locations. Turnover at least one set of both electronic and printed records, per the Owner's request.

G. Comply with training requirements of section 270000. For this System, provide up to 4 hours of training for the Owner.

3.21 WARRANTY PERIOD MAINTENANCE

A. A. Correct deficiencies within 24 hours of notification during the warranty period.

3.22 EXTENDED SERVICES

A. Submit costs for extended services (additional service levels beyond the warranty period) as follows:
   1. One-year, two-year, and three-year service with quarterly pre-emptive maintenance calls and same-day issue response
   2. One-year, two-year, and three-year service with quarterly pre-emptive maintenance calls and 24-hour issue response
   3. One-year, two-year, and three-year service with quarterly pre-emptive maintenance calls and 48-hour issue response

3.23 PROJECT CLOSEOUT

A. Refer to 27 00 00

END OF SECTION

SECTION 31 00 00
EARTHWORK UNDER BUILDING PAD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Protecting and preserving trees and vegetation to remain.

B. Clearing, stripping, and grubbing of portions of sites which are below the building pads.

C. Stockpiling stripped topsoil in approved locations.

D. Excavating for and otherwise providing stable and compact subgrade below the building pads.

E. Placing and compaction of select fill under improved areas to conform to elevations indicated on the drawings.

F. Filling and finish grading of area around buildings and other improvements using imported topsoil per section 2.1,D.

G. Coordinating Work of other Sections affecting or affected by Work of this Section.

1.2 INSPECTION OF SITE

A. By making a proposal on the Project, the Contractor acknowledges:
   1. That the Owner and Architect do not guarantee the accuracy, completeness, or suitability of the contents of the Geotechnical Report or Topographic Survey.
   2. That he/she has visited the site to investigate the conditions affecting the Work and has satisfied himself/herself of the character, quality and quantity of surface and subsurface materials or obstacles to be encountered.

B. The Contractor will be required to establish, maintain and be responsible for all reference points, hubs, grades, elevations, lines, and surface measurements. If any discrepancies in the documents are found, the Contractor shall promptly notify the Architect and await instructions before proceeding.

1.3 QUALITY ASSURANCE

A. Inspection and Testing Laboratory Services: Test results shall meet or exceed the standards referenced.

1.4 REFERENCES

A. ASTM International (ASTM)
   1. D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3) – Test for Moisture Unit Weight Relations of Soils and Soil Aggregate.
   2. D2922, Tests for Density of Soil and Soil Aggregate in place by Nuclear Methods.

1.5 PRE-INSTALLATION CONFERENCE

A. Refer to Section 01 31 13- Project Management and Coordination.

PART 2 - MATERIALS

2.1 MATERIALS

A. Structural Fill: Sandy clay soils free of organic or other deleterious materials, and have a maximum clay lump size of less than three (3) inches. See Construction Documents for Liquid Limit and Plasticity Index per soils report.

B. Earth Fill: Shall be excavated material approved by Architect prior to its use as earth fill around building and landscaped areas, but not under building.

C. Stabilization Materials: Refer to stabilization section(s) in Division 31.

D. Topsoil: Shall be imported, and shall be free from clay, vegetation, debris, stumps, roots, stones larger than 3/4 inch diameter, or other objectionable matter.

PART 3 - EXECUTION

3.1 GENERAL

A. Unknown Utilities and Obstacles:
   1. If any unknown or uncharted utilities or objects are encountered during excavation, promptly notify the Architect before proceeding. Arrange with utility and telephone companies for removal and relocation of their equipment, and capping of pipes and wiring as required.

B. Protection of Vegetation:
   1. Rope or fence off areas of the site that are designated to remain with vegetation to prevent vehicular traffic and construction damage.
   2. Provide wood barricades around trees and shrubs at their drip line in traffic areas to protect them from construction operations until Substantial Completion, or until barricade removal is directed by Architect.
   3. Replace damaged trees and vegetation designated to remain with vegetation of equal kind and size. Follow supplier's recommended procedures for planting necessary replacement vegetation.

C. Clearing, Stripping and Grubbing (General):
   1. Remove brush, vegetation, debris, and surplus materials from the jobsite. Removal of other remaining impediments as may be necessary to properly execute the scope of this contract shall be included herein. Adhere to State and local code requirements for the disposal of trees and shrubs removed from the site.

2. Do not remove trees or shrubs without the specific approval of the Architect. Vegetation damaged, removed, killed, or constricted from normal growth patterns shall be replaced with a comparable item, or the full replacement amount credited to the Owner.

D. Drainage, Pumping and Grading:
1. Proper drainage of site shall be maintained during construction so that ponding of surface runoff does not occur and cause construction delays and/or inhibit access to the site.
2. Contractor shall control the grading around building so that ground is pitched to prevent water from running into the excavated areas of building or damaging other structures.
3. Provide pumping required to keep excavated spaces clear of water during construction.
4. If any subgrade is damaged due to flooding, damaged area shall be removed and filled with select fill. Placement and compaction of select fill shall meet the requirements for placing and compacting select fill as specified below.
5. If the subgrade, due to any reason or cause, lose the required stability, density, or finish before the foundation structure is placed, it shall be re-compacted and refinished at the sole expense of the Contractor.

3.2 BUILDING FOUNDATION (PAD) PREPARATION

A. Site preparation area at buildings with and without adjacent sidewalks shall extend beyond the limits of the foundation area. See Construction Documents for Site Preparation limits.

B. Existing fill material, top soil vegetation, roots, debris, organic material and other miscellaneous debris shall be removed to a depth of 9 inches and legally disposed of. Actual removal depth may vary and will be determined at time of construction.

C. Over excavate the in-situ soils as required to allow the minimum amount of select structural fill to be placed beneath the slab to achieve the desired elevation. See Construction Documents for amount of select structural fill required per soils report.

D. After stripping, and excavating to the desired grade as indicated above, the exposed soil shall be proof-rolled to locate all soft or loose areas. Soils, which are observed to rut or deflect excessively under the moving load, shall be undercut and replaced with properly compacted structural fill. The proof-rolling and undercutting activities shall be witnessed by a representative of the geotechnical engineer and shall be performed during a period of dry weather.

E. Subsequent to proof-rolling, and just prior to placement of fill, the exposed subgrade within the construction areas shall be evaluated for moisture and density. The subgrade soils shall be at or above the optimum moisture content, and have an in-place dry density of at least 95 percent of the standard effort (ASTM D698) maximum dry density of the in-situ soils. If the moisture or density does not meet the above criteria, the subgrade shall be scarified to a minimum depth of 6 inches, and moisture adjusted to meet the requirements per the soils report as indicated on the Construction Documents.

F. If remediation is required, Contractor shall have any of the following remediation options:
1. Disking and drying with natural means (if the construction schedule allows).

2. Dry the surface soils by chemically treatment.
3. Remove the unsuitably wet soils and replace the wet soil with select fill having an acceptable moisture content.

The option will be entirely up to the Contractor and no extra will be paid by the Owner.

G. After proof-rolling and undercutting has been completed, and the subgrade tested and adjusted as necessary, fill placement may begin. The first layer of fill shall be placed in a relatively uniform horizontal lift and be adequately keyed into the stripped subgrade soils.

H. Refer to construction drawings for information regarding lime-stablized subgrade treatment.

3.3 FILL PLACEMENT

A. Structural fill materials shall be as specified in Paragraph 2.1, A above. Structural fill shall be placed in maximum lifts of eight (8) inches of loose material and shall have a moisture content as indicated on the Construction Documents. If water must be added, it shall be uniformly applied and thoroughly mixed into the soil by disking or scarifying. Each lift of structural fill shall be tested by a representative of the geotechnical engineer prior to placement of subsequent lifts.

B. Each lift of structural fill shall be compacted as required per the soils report and as indicated on the Construction Documents. Care shall be taken to apply compactive effort throughout the fill and fill scope areas. The moisture content and the degree of compaction of the structural fill soils shall be maintained until the construction of structures above them.

C. Contractor shall be responsible for damage caused to structure because of over excavation or excavations left open during inclement weather. Should the subgrade, for any reason or cause, lose the required stability, density, or finish before the foundation structure is placed, it shall be re-compacted and refinished at the sole expense of the Contractor.

3.4 GRADING

A. Rough Grading: Contractor shall control the grading around building so that ground is pitched to prevent water from running into the excavated areas or damaging other structures. Furnish pumping required to keep excavated spaces clear of water during construction. If a foundation excavation must remain empty through a shut-down period, cover with boards and building paper and clean out immediately when work resumes. If any subgrade should be damaged due to flooding, damaged area shall be removed and filled with select fill.

B. Finish Grading:
1. After rough grading is completed, provide and place imported top soil in the amounts required to bring the rough grade to within two (2) inches of finish grade. This earth fill shall be placed in lifts not to exceed 12 inches after compaction and shall be compacted to a dry density of at least 95 percent of the ASTM D698 maximum dry density.
2. Assure bonding of layers of fill material in compliance with the specifications.

3. Final and fine grading shall be done using a tractor pulled landscape rake and hand raking removing all debris immediately prior to landscaping. The final graded ground surface shall be relatively smooth, free of organic material and in suitable condition to commence landscaping work.

C. Topsoil:
1. Contractor shall furnish all topsoil that may be required to provide finish elevations. Topsoil material shall meet requirements of Paragraph 2.1 of this Section. Spread minimum two (2) inches of topsoil over graded areas after rough grading has been completed.
2. At the completion of finish grading, ground surface shall be relatively smooth, free of organic material and in suitable condition to commence landscaping work.

3.5 INSPECTION AND TESTING LABORATORY SERVICES

A. Refer to Section 01 45 23, Inspection and Testing Laboratory Services for laboratory services to determine the liquid limit, plastic limit and plasticity index for soils and in-place density tests for compacted material.

B. The Contractor shall cooperate with the inspection and testing laboratory in all matters pertaining to the work.

END OF SECTION 31 00 00

SECTION 31 00 01
EARTHWORK

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required and perform all excavation, backfill, fill and grading required to complete the work as shown on the Drawings and as specified herein. The work shall include but not necessarily be limited to; excavation and backfill for electrical manholes, handholes, conduits, cables, raceways, and ducts; embankment and grading; disposal of waste and surplus materials; and all related work such as sheeting, bracing, and dewatering.

B. All excavation, trenching and related sheeting, bracing, etc., shall conform to the requirements of the Texas "State Safety Act" (CS/SB 2626) which incorporates, by reference, OSHA's excavation safety standards, 29 CFR 1926.650 Subpart P.

C. Excavation, backfill, and compaction for structures and piping are included in other sections as listed below.

1.02 RELATED WORK

A. Dewatering and Drainage is included in Section 312319 and 014127.

B. Rock and Boulder Excavation is included in Section 312319.

C. Structural Excavation Backfill and Compaction are included in Section 312319.

D. Trenching and Backfilling for Utilities is included in Section 330528.

1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM) 1. ASTM C33 - Specification for Concrete Aggregates.

2. ASTM DI557- Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,00 ft-lb./ft (2,700kN-m/m)

3. ASTM D1682- Standard Test Methods for Breaking Load and Elongation of Textile Fabrics.
4. ASTM D2487 - Standard Classification of Soils for Engineering Purposes.

5. ASTM D4751- Standard Test Method for Determining the Apparent Opening Size of a Geotextile.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 PROTECTION

A. Sheeting and Bracing

1. Furnish, put in place and maintain such sheeting and bracing as may be required: by Federal, State and local safety requirements; to support the sides of excavations; to prevent any movement which could in any way diminish the width of the excavation below that necessary for proper construction; and to protect adjacent structures from undermining or other damage. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed. Where soil cannot be properly compacted to fill a void, lean concrete shall be used as backfill.

2. To protect adjacent structures, installation or removal of sheeting by vibratory or hammering methods shall not be allowed.

3. Construct the sheeting outside the neat lines of the foundation, unless indicated otherwise, to the extent deemed desirable for the method of operation. Sheeting shall be plumb and securely braced and tied in position. Sheeting and bracing shall be adequate to withstand all pressures to which the structure or trench will be subjected. Any movement or bulging which may occur shall be corrected to provide the necessary clearances and dimensions.

4. Where sheeting and bracing is required to support the sides of excavations for structures, engage a professional Engineer, registered in the State of Texas to design the sheeting and bracing. The sheeting and bracing installed shall be in conformity with the design and certification of this shall be provided by the professional Engineer. Submit P.E. Certification Form contained in Section 01 33 23 to show compliance with this requirement.

5. All sheeting and bracing not left in place shall be carefully removed in such manner as not to endanger the construction or other structures, utilities, or property. All voids left or caused by withdrawal of sheeting shall be immediately refilled with sand by ramming with tools especially adapted to that purpose, or otherwise as may be directed.
6. The right of the ENGINEER to order sheeting and bracing left in place shall not be construed as creating any obligation on his/her part to issue such orders and his/her failure to exercise his/her right to do so shall not relieve the CONTRACTOR from liability for damages to persons or property occurring from
or upon the work occasioned by negligence or otherwise, growing out of a failure on the part of the CONTRACTOR to leave in place sufficient sheeting and bracing to prevent any caving or moving of the ground.

7. No sheeting is to be withdrawn if driven below mid-diameter of any pipe and under no circumstances shall any sheeting be cut off at a level lower than 1-ft above the top of any pipe.

B. Pumping and Drainage

1. At all times during construction provide and maintain proper equipment and facilities to remove all water entering excavations and keep such excavations dry so as to obtain a satisfactory undisturbed subgrade foundation condition until the fills, structures or pipes to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural levels. Engage a Geotechnical Engineer registered in the State of Texas to design the dewatering system in accordance with Section 312319 prior to commencing work.

2. Dewatering shall always be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation. Well or sump installations shall be constructed with proper sand filters to prevent drawing of finer grained soil from the surrounding ground.

3. Take all additional precautions to prevent uplift of any structure during construction.

4. Removing the dewatering equipment after the system is no longer required.

1.05 SOIL TESTING

A. Before the general placement of the fill and during such placement, the ENGINEER may select areas within the limits of the fill to test the degree of compaction obtained. Cooperate fully in obtaining the information desired.

B. Payment for testing will be made by the OWNER CONTRACTOR as part of the project. If test results are unsatisfactory, all costs involved in correcting deficiencies in compacted materials to the satisfaction of the ENGINEER, will be borne by the CONTRACTOR.

PART 2 PRODUCTS

2.01 MATERIALS

A. Select Common Soil and Structural Fill shall be as specified in Section 312323.

B. Common soil shall be as specified in Section 312323.

C. Crushed Stone

1. Crushed stone shall conform to Texas Department of Transportation Class 57 stone gradation.

D. Screened Gravel

1. Screened gravel shall be used for pipe bedding as detailed and at other locations indicated on the Drawings.

2. Screened gravel shall consist of hard, durable, rounded or subangular particles of proper size and gradation and shall be free from sand, loam, clay, excess fines and deleterious materials. The gravel shall be graded within the following limits:

Sieve Size	Percent Finer by Weight
5/8-in	100
1/2-in	40 to 100
3/8-in	15 to 45
No.10	0 to 5

PART 3 EXECUTION

3.01 BACKFILLING - COMMON FILL

A. Common Fill may be used as trench backfill and fill against exterior walls of structures as indicated on the Drawings; as embankment fill; or in other areas as designated by the ENGINEER. Material conforming to the requirements of common fill shall be placed in layers having a maximum thickness of 2-ft measured before compaction.

B. Common Fill shall be compacted to at least 95 percent of maximum density as determined by ASTM D1557, Method D.

C. Materials placed in fill areas shall be deposited to the lines and grades shown on the Drawings making do allowance for settlement of the material and for the placing of loam thereon.

D. The surfaces of filled areas shall be graded to smooth true lines, strictly conforming to grades indicated on the grading plan and no soft spots or uncompacted areas will be allowed in the work.

E. No compacting shall be done when the material is too wet either from rain or from excess application of water. At such times, work shall be suspended until the previously placed and new materials have dried sufficiently to permit proper compaction.

3.02 DISPOSAL OF SURPLUS MATERIAL

A. No excavated materials shall be removed from the site of the work or disposed of, except as specified by the ENGINEER. Materials shall be neatly piled to inconvenience as little as possible by the public and adjoining property OWNERS until used or otherwise disposed of as specified below.

B. Suitable excavated material shall be used for filling embankments or backfill on the different parts of the work as required.

C. Surplus fill shall become the property of the CONTRACTOR and shall be removed and disposed of offsite.

3.03 DISPOSAL AND REPLACING OF ROCK

A. Remove and dispose of all pieces of ledger and boulders which are not suitable for use in other parts of the work. Rock disposed of by hauling away to spoil areas is to be replaced by approved surplus excavation obtained elsewhere on the work, insofar as it is available. Any deficiency in the backfill material shall be made up with acceptable material approved by the ENGINEER.

B. Fragments of ledge and boulders smaller than 50 lb. weight may be used in back-filling trenches unless in the opinion of the ENGINEER the quantity is excessive, in which case he/she may order the removal and disposal of some of this rock. The small pieces of rock used as backfill shall not be placed in trenches until the pipe has at least 2-ft of earth over it. Place these pieces of stone in thin layers alternating them with earth to be sure that all voids between the stones are filled with earth to prevent the occurrence of voids and settlement which will result therefrom.

C. Rock may be used in embankment fill only with the approval of the ENGINEER.

3.04 GRADING

A. Grading in preparation for placing of loam, planting areas, paved walks and drives and appurtenances shall be performed at all places that are indicated on the Drawings, to the lines, grades and elevations shown and otherwise as directed by the ENGINEER and shall be performed in such a manner that the requirements for formation of embankments can be followed. All material encountered, of whatever nature, within the limits indicated, shall be removed and disposed of as directed. During the process of grading, the subgrade shall be maintained in such condition that it will always be well drained. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the prosecution or condition of the work.

B. If at the time of grading it is not possible to place any material in its final location, it shall be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling or double handling of excavated material.

C. The right is reserved to make minor adjustments or revisions in lines or grades if found necessary as the work progresses, to obtain satisfactory construction.

D. Stones or rock fragments larger than 4-in in their greatest dimensions will not be permitted in the top 6-in of the finished subgrade of all fills.

END OF SECTION 31 00 01

SECTION 31 11 00
CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for Site clearing which may consist of:
1. Protection of trees indicated to be preserved.
2. Protection of above-ground and below-ground existing improvements indicated to be preserved.
3. Clearing, grubbing, removal and disposal of trees, stumps, brush, roots, vegetation, logs and rubbish.
4. Removal and disposal of above-ground and below-ground materials and existing improvements, including building demolition if any, as indicated.
5. Stripping and stockpiling of topsoil.
6. Stripping and stockpiling natural leaf mulch.

1.02 SUBMITTALS

A. In accordance with Section 01 33 00 – Submittal Procedures.

1.03 JOB CONDITIONS

A. Conduct demolition operations and removal of debris in accordance with governing regulations and Section 024117 - Demolition of these Specifications.
B. Ensure minimum interference with adjacent occupied or used facilities.
C. Exercise cares to protect adjacent buildings, structures, and people.
D. Above-ground and below-ground existing improvements, indicated to remain, shall be protected from damage prior to and during construction operations.

E Tree Protection

1. Trees to be preserved shall be protected by barricades to avoid any confusion and damage prior to site clearing operations.
2. Contractor shall install barricades 3 ft. beyond drip line of trees to be protected. Construction equipment or storage activities shall not be permitted within the fenced area.

F. Protection of Existing Utilities and Adjacent Work

1. Prior to earthwork operations, existing utilities, facilities and permanent objects to remain shall be located and adequately protected. When working near public and private utility company lines, Contractor shall contact the local utility coordinating committee, or the utility company involved to locate their lines.
2. If unknown and uncharted utilities are encountered during excavation, promptly notify Owner and the governing utility companywhen determinable and wait for instructions.
3. If it is determined by Owner that such utility line has been abandoned, properly cap line at a depth approved by Owner or remove line as directed.
4. If such unknown utilities are encountered and work is continued without contacting the Owner for instructions, and the encountered utilities are damaged by continuation of the work, Contractor shall repair, at this own expense, such damage to the satisfaction of the Owner and the Utility Company. The Contractor shall be responsible for all costs to repair the damage.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 CLEARING

A. Trees to be removed, stumps, brush, roots and vegetation shall be removed to a depth of not less than 2 feet below original or finish ground level, whichever is lower.
B. Miscellaneous vegetation, logs and rubbish shall be removed in their entirety, within the limits of improvements.

D. Topsoil shall be stripped to underlying subsoil. Topsoil shall be defined as friable organic clay loam surface soil, reasonably free of clay lumps, stones, weeds, roots and other objectionable material. Topsoil shall be safely stockpiled on the Site. Stockpiles shall be constructed to freely drain surface water.
E. Depressions caused by clearing, grubbing and stripping operations shall be filled with approved backfill material, unless further excavation is required by the construction operations. Backfill shall be placed in accordance with Section 312300 – Grading, Excavation and Fill of these Specifications.

3.02 REMOVAL OF IMPROVEMENTS

A. Above-ground and below-ground existing improvements shall be removed in their entirety, except for utilities which shall be removed only to the extent indicated. Where utilities are indicated to be removed in part, the ends of the remaining utilities shall be permanently plugged with Class 3000 concrete.

3.03 DISPOSAL OF MATERIALS

A. Materials not scheduled to be salvaged shall become the property of the Contractor and shall be removed from the Site and legally disposed of. Burning or burying cleared, grubbed and demolition waste materials on the Site shall not be permitted.
B. Remove items, without damaging, scheduled to be salvaged as directed by the engineer and placed in designated storage area.

END OF SECTION 31 11 00

SECTION 31 23 00
GRADING EXCAVATION AND FILL

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Protection of trees.

B. Field engineering for site layout.

C. Testing laboratory services.

D. Fill material for pavement subbase.

E. Concrete reinforcing.

F. Cast-in-place concrete.

G. Informational reference to site survey and to subsurface conditions.

1.02 QUALITY ASSURANCE

A. Reference standards:

1. ASTM D 698, test for moisture-density relations of soils (standard proctor).
2. ASTM D 2922, test for density of soil in place by nuclear method.
3. ASTM D 2487, classification of soils for engineering purposes.

1.03 SUBMITTALS

A. Samples:

1. Submit 10 pound sample quantity of fill materials.
2. Submit 20 pound sample quantity of topsoil material.
3. Pack tightly in containers to prevent contamination.

1.04 GRADES

A. Carefully compare new grade requirements with existing conditions.

B. Provide necessary earth, grading and shaping work.

C. Extra payment will not be authorized for overage or shortage of material.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Subbase Material: Unwashed pit run or crushed gravel, crushed stone, or crushed slag, naturally or artificially graded with maximum aggregate size of 1-1/2 inches, as acceptable to testing laboratory.

B. Backfill and Fill Material: Soil materials free of debris, waste, frozen matter, vegetable and other deleterious matter, as acceptable to testing laboratory.

C. Select Fill: Imported lean clay with a narrow plasticity index (pi) range of 10 to 15.

D. Lime Treated Structural Fill: On-site clay mixture, free of silt, loam, friable or soluble materials and organic matter; treated in 6 inch lifts with 36 pounds per square yard of hydrated lime.

E. BackfilL:

1. Free from rocks larger than 3 inches in size, alkali, salt, petroleum products, debris, waste, roots, vegetable and other deleterious matter.

2. Excess non-vegetated excavated soils available from site may be used if conforming to specified requirements.

F. Lime: Material conforming to SDHPT Item 264, "Hydrated Lime and Lime Slurry".

G. Soil Filter Fabric: MIRAFI "1405" is specified; DUPONT "Typar" is acceptable, or approved equal.

PART 3 – EXECUTION

3.01 OBSTRUCTIONS

A. Remove obstructions within lines of improvements.

B. Refer obstructions of questionable nature to engineer.

C. Remove abandoned foundations down to 12 inches below finished grade, or the finished elevation of pavements and walks unless indicated otherwise on the drawings.

D. Remove foundations of light standards completely.

3.02 STRIPPING

A. Strip entire area to receive pavement and slabs on grade to a minimum depth of six inches to remove soil containing vegetated material.

B. Remove vegetated material from site as waste.

C. Remove Topsoil; Spread on areas already graded and prepared for topsoil, or deposit in storage piles convenient to areas subsequently to receive topsoil.

D. Scarify existing asphalt surfacing and flexible base course material and remove from site.

E. Remove existing site improvements in areas scheduled to receive lawns, buildings, and pavements.

F. Stripped material becomes property of contractor; remove from project site immediately and dispose of properly.

G. Maintain site surface drainage during construction.

3.03 EXCAVATION AND COMPACTION BELOW GRADE BEAMS AND SLABS-ON-GRADE

A. Excavate sub grade for the building footprint to allow a minimum of 4 feet of thickness below the bottom of the slabs-on-grade. In accordance with lines and grades required for construction of the work, including space for placing and removal of forms, bracing and shoring, for inspection and a minimum of 5 feet beyond the building line.

B. Maintain excavations free of loose earth, debris, and keep dry until placement of concrete.

C. Proof roll the soil at the base of the excavation using a rubber-tired vehicle weighing about 20 tons, such as a loaded dump or water truck.

D. Remove and replace any soft or weak soils identified. Disking, drying and recompaction during weather dry or treatment with a chemical additive may be used as needed as remedial options.

E. Place a minimum 3 feet thickness structural fill and select as recommended by the soils report, fill as indicated, in consecutive 8 inch maximum loose lifts. compact any lime treated clay and select fill to at least 95 percent of the standard proctor maximum density according to ASTM D698.

F. If high moisture content is determined by astm d698, compare the in-place density of lime-treated clays with 90 percent of the maximum density determined by modified effort according to ASTM D1557, if required. The actual range of moisture within which specified compaction can be achieved may be adjusted once the moisture-density relationship for the structural fill has been developed.

G. Protect open excavations with coverings as necessary to maintain existing soil moisture content.

3.04 EXCAVATION FOR UTILITY TRENCHES

A. Excavate using ladder-type trenching machine or backhoe unless indicated otherwise.

B. Cut trench sides vertical from trench bottom to one foot above top of pipe; slope back on stable slope above that point.

C. Extend trench width minimum 6 inches and maximum 18 inches each side of pipe.

D. Excavate trench to a minimum depth of 4 inches below bottom elevation of proposed pipelines.

E. Leave no more than 500 feet of trench open at one time.

F. Where augured hole is indicated, provide opening no larger than one inch greater than outside diameter of pipe bell.

3.05 DEWATERING

A. Keep excavations dry; maintain dewatered condition for depth of one foot below excavation bottom.

B. Operate suitable pumps necessary to keep excavations continuously free of water.

C. Discharge drainage waterlines into approved sewers only with appropriate approvals; use of sanitary sewer is prohibited.

D. Direct surface drainage away from excavated areas.

E. Control grading adjacent to excavations to prevent water running into excavated areas.

3.06 PERIMETER BACKFILL

A. Backfill exterior side of perimeter of structure with lime-treated on-site clay materials, carrying such fill up to indicated subgrades.

B. Backfill systematically and as early as possible to allow maximum time for natural settlement and compaction.

C. Commence backfilling after underground work has been inspected, tested, forms removed, and excavation cleaned of trash and debris.

D. Place and compact backfill to minimize settlement and avoid damage to work in place.

E. Place backfill simultaneously on both sides of freestanding structures; prevent wedging action against structure.

F. Place materials in successive horizontal layers of not more than 8 inches (4 inches for hand-held tamping equipment) and uniformly compacted to 92% of maximum density as confirmed by testing laboratory.

3.07 UTILITY TRENCH BACKFILL

A. Pipe bedding and backfill requirements for sanitary sewers shall be as specified in Section 333100 - Sanitary Sewage Systems.

B. Pipe bedding and backfill requirements for storm sewers shall be as specified in Section 334100 - Storm Sewage Systems.

C. Pipe bedding and backfill for water distribution system piping shall be as specified in Section 321100 - Water Distribution Systems.

D. Backfill trench as soon as possible after pipe has been laid, jointed, and inspected; complete backfilling at end of each day. Within pipe zone: place backfill material and hand tamp in 6 inch layers to one foot above top of pipe.

E. Use of bulldozer or similar tracked equipment is unacceptable for compaction.

3.08 PREPARATION OF SUBGRADE FOR PAVING, WALKS AND EXTERIOR SLABS

A. Cut and fill areas as required.

B. Proof roll sub grade with heavy roller. cut out any soft area that cannot be compacted by surface rolling and replace with compacted select fill.

C. Provide select fill at areas where required to elevate sub grade. lime stabilization: stabilize to depth of 8 inches with lime slurry in accordance with TxDOT Item 260. Subgrade beneath sidewalks shall not be lime stabilized.

D. Compact to not less than 85 to 92% of maximum density in accordance with ASTM D698 as confirmed by testing laboratory; with moisture content for compacted material within +/- 2% of optimum moisture.

E. Maintain site surface drainage during construction.

3.09 ROUGH GRADING

A. Shape subgrade to allow for maximum amount of natural settlement and compaction.

B. Remove debris, roots, branches, stones, in excess of 2 inches in size.

C. Remove subsoil which has been contaminated with petroleum products.

D. Excavate areas to subgrade elevation, which are to receive paving and sidewalks.

E. Bring subgrade to required levels, profiles and contours, making gradual changes in grade; blend slopes into level areas.

F. Slope grade away from building minimum 2 inches in 10 feet unless indicated otherwise.

G. Cultivate subgrade to a depth of 3 inches where topsoil is to be placed; repeat cultivation in areas where equipment used for hauling and spreading topsoil has compacted subgrade.

H. Maintain site surface drainage during construction.

3.10 SURPLUS MATERIALS

A. Remove surplus subsoil from site.

3.11 CLEANUP

A. Remove temporary structures, rubbish, and waste materials from work site daily.

END OF SECTION 31 23 00

SECTION 31 25 00
EROSION AND SEDIMENTATION CONTROL

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. This Section pertains to the provisions for the control of erosion in the construction area and in stockpile areas including seeding, the construction of temporary swales and sedimentation basins as required and shown on the drawings. All areas where existing vegetation and grass cover have been borne by construction activities shall be protected from erosion.

B. Contractor is responsible for meeting all local, state and federal regulations regarding erosion control including the applicable provisions of the National Pollution Discharge Elimination System, Phase II, regulations from the Clean Water Act.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the Contract, including A-Procurement and Contracting Requirements, Division 00 and Division 01 apply to this section.

B. Section 31 11 00 Clearing and Grubbing

C. Section 31 23 00 Grading Excavation and Fill

D. Section 33 05 28 Trenching and Backfill for Utilities

E. Texas Department of Transportation’s Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges (2014)

1.03 PERMITS (NOT USED)

1.04 APPLICABLE PUBLICATIONS (NOT USED)

1.05 PROTECTION OF ADJACENT WORK (NOT USED)

1.06 DEFINITIONS

A. Best Management Practices (BMP's) means physical facilities schedules of activities, prohibition of practices, maintenance procedures, and other management practices, when properly designed, installed, and maintained, will be effective to prevent or reduce the discharge of pollution associated with construction activities. BMPs also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

B. Block Sodding: Sodding for erosion control and for final stabilization shall consist of providing and planting Bermuda grass, San Augustine grass, or other acceptable sod along or across such areas as are designated on the drawings and in accordance with the specification requirements herein outlined.

C. Hydro mulch Seeding: Seeding, followed by the application of a mulch erosion control blanket shall consist of preparing the ground, sowing of seeds, application of a fertilizer, and stabilization with mulch consisting of a biodegradable fiber along and across such

areas as are designated on the plans and in accordance with these specifications

D. Silt Fence: The reinforced filter fabric barrier consists of geotextile fabric supported by a net reinforced fence stretched across and attached to supporting posts or frame and entrenched. Work shall be performed during construction operations and prior to final stabilization to control erosion and sedimentation as designated on the plans and in accordance with these specifications.

E. Inlet Protection Barriers: The inlet protection barrier consists of a geotextile fabric (filter fabric) supported by a net reinforced fence structure and constructed around a storm drain inlet, catch basin, or culvert. An alternative design of the inlet protection barrier, as approved by the Engineer, consists of fiber rolls placed around a frame, staked in place (or weighted down with clean gravel bags), and constructed around a storm drain inlet, catch basin or culvert. This work shall be performed during construction operations and prior to final stabilization to control erosion and sedimentation. As designated on the plans and in accordance with these specifications.

F. Sediment Basins: A sediment basin is a temporary basin or dam constructed across a waterway or excavated location to intercept sediment-laden runoff and to trap and retain the sediment. A sediment basin is usually installed at points of discharge from drainage areas greater than 5 acres. Work shall be performed during construction operations and prior to final stabilization to control erosion and sedimentation as designated on the plans and in accordance with these specifications.

G. Stabilized Construction Access: This work shall consist of the installation of temporary erosion protection and sediment control stabilized construction access - type I, rock, utilized during construction operations and prior to final stabilization, in accordance with these specifications and construction drawings

H. Rock Filter Dams: Rock filter dams are temporary berms constructed of stone to intercept and slow storm water runoff to retain sediment on the construction site.

1. Depending upon the type of rock filter dam specified in the construction plans as Type 1, 2, 3, or 4, the aggregate fill may be unwrapped, wrapped in twisted hexagonal wire mesh, or confined in a gabion wire basket. Applications of Rock Filter Dams are as follows:

a. Type 1 dams may be used at slopes, around inlets, in small ditches, and at dike or swale outlets. Type 1 dams are recommended for erosion and sediment control from a drainage area of 5 acres or less.

b. Type 2 dams may be used in ditches and at dike or swale outlets.

c. Type 3 dams may be used in stream FL

d. Type 4 sack gabions may be used in ditches and smaller channels to form an erosion and sediment control dam

1.07 QUALITY ASSURANCE

A. Codes and Standards: Install and maintain erosion control systems in compliance with all authorities having jurisdiction.

1.08 PROJECT/SITE CONDITIONS (NOT USED)

1.09 SUBMITTALS (NOT USED)

PART 2 – PRODUCTS

2.01 SUSTAINABLE MATERIALS

A. Contractors shall strive to utilize sustainable materials, which include rapidly renewable materials, regional materials, regionally manufactured materials, regionally extracted materials, recycled contents.

2.02 GRASS

A. Materials for erosion control seeding shall conform to TxDOT Item 164.

B. Materials for erosion control sodding shall conform to TxDOT Item 162.

2.03 FERTILIZER

A. Materials for fertilizing erosion control seeding and/or sodding shall conform to TxDOT Item 166.2

2.04 WATER

A. Use clean potable water for maintaining the grass developed after erosion control seeding and/or sodding. Water shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable matter or other substances injurious to the finished product.

B. Water sources other than the local municipal domestic water supply must be approved by the Owner.

C. If onsite reclaimed water sources are used, tanks and apprentices must be clearly marked with the words “non-potable” water.

2.05 SILT FENCE

A. Geotextile fabric for Silt Fences must meet the TxDOT Departmental Material Specifications DMS 6230 Temporary Sediment Control Fence Fabric.

2.06 STRAW BALES

A. Standard rectangular hay bales bound by baling wire, clean and dry

2.07 INLET PROTECTION BARRIERS

A. Geotextile per 2.5 Silt Fence above.

B. Hardwood Posts shall be 2x2 minimum length 4 feet.

C. Net reinforced fences shall be 2- inch by 4-inch welded wire fabric mesh. The mesh support height shall be the equivalent height, or greater, of the geotextile fabric to be attached.

2.08 STABILIZED CONSTRUCTION ACCESS

A. Materials to be per TxDOT spec section 506.2.E.1 for Type 1

2.09 ROCK FILTER DAM

A. Materials. Geotextile fabric shall consist of a woven monofilament or spun bond nonwoven fibers consisting of long-chain synthetic polymers composed of at least 95 percent by weight of polyolefins. Geotextile fabric shall equal or exceed the following average roll values or as directed by the Engineer:

1. Minimum average roll value.

a. Elongation – 50 percent.

b. Grab Strength – 200 pounds.

c. Puncture Strength – 75 pounds.

d. UV Stability (retained strength) – 50 percent after 500 hours of exposure.

2. Maximum average roll value.

a. Apparent Opening Size (AOS) – 0.6 mm/#30 US sieve.

B. Geotextile fabric shall be resistant to commonly encountered soil chemicals, mildew, rot, insects, and deterioration resulting from exposure to sunlight or heat. Geotextile fabric shall provide an expected useable life comparable to the anticipated construction period.

C. Aggregate for the rock filter dams shall consist of crushed stone. Aggregate particles shall be composed of clean, hard, durable materials free from adherent coatings, salt, alkali, dirt, clay, loam, shale, soft or flaky materials or organic and injurious matter. Aggregates shall be cubic or rounded form, not elongated, flat, shaped. Spalls, fragments, and chips shall not exceed 5 percent by weight. Crushed concrete shall not be substituted for the crushed stone unless as approved by the Engineer. Aggregate size shall depend upon the type of rock filter dam specified in the construction plans. Aggregate size based on type of rock filter dam is as follows:

1. Type 1: 3 inches to 5 inches, open-graded.

2. Type 2: 3 inches to 5 inches, open-graded.

3. Type 3: 4 inches to 8 inches, open-graded.

4. Type 4: 3 inches to 5 inches, open-graded.

D. Mesh is required for reinforced type rock filter dams. Mesh shall be 20 gauge galvanized double twisted hexagonal wire mesh with 1-inch diameter hexagonal openings. Mesh wire shall be zinc coated prior to being double twisted. Reinforcing spiral binders, lacing wire, and stiffeners shall be made of wire having the same coating material and same wire size as the wire mesh. Gabion wire baskets shall equal or exceed the requirements of the wire mesh.

PART 3 – EXECUTION

3.01 GENERAL

A. Protection

1. Protect benchmarks, monuments, existing structures, existing fences, existing roads, existing sidewalks, existing paving, existing curbs, and other features indicated on Drawings to remain, or not indicated to be removed, from damage and displacement. If damaged or displaced, notify Engineer and correct defects as directed.

2. Protect above and below grade utilities which are to remain.

B. Preparation:

1. Use all means necessary to control dust on and near the work, and on and near off-site storage, and spoil areas, if such dust is caused by performance of the work of this Section, or if resulting from the condition in which Project Site is left by Contractor.

2. Moisten surfaces, as required, to prevent dust from being a nuisance to the public, neighbors, and concurrent performance of other work on Project Site.

C. Install erosion control systems at the site's boundary at locations where stormwater runoff will leave the site prior to starting any clearing, stripping, or earthwork operations

D. Minimize the time areas are to be exposed without vegetative cover.

E. Properly dispose of solid waste, paints, solvents, cleaning compounds, etc.

F. Store construction materials in designated areas away from drainageways and low areas.

G. Provide portable toilets and properly dispose of sanitary sewage.

H. Construct containment berms and utilize drip pans at fuel and liquid storage tanks and containers.

3.02 INSTALLATION OF EROSION CONTROL DEVICES

A. Install erosion control devices to protect adjacent and downstream properties from damage and pollution resulting from erosion caused by the work of this Contract.

1. Implement erosion control measures indicated on drawings and additional erosion control measures necessary to prevent damage to adjacent and downstream properties.

B. Install silt fence located along perimeter of site or grading limits immediately following site clearing operations specified under Division 31 Section 31 11 00 Clearing and Grubbing.

1. Install silt fence fabric from a continuous roll for the length of the silt fence whenever possible to minimize the number of joints.

a. Create joints in fabric by securely fastening fabric at the support post with overlap extending to the next post.

2. Drive support post into ground not less than 18 inches.

3. Excavate a 4-inch-wide by 4-inch-deep trench on up-slope side of silt fence.

   a. Line trench with silt fence fabric material.

   b. Backfill trench with soil or gravel.

C. Install straw bale fence at completion of grading operations in affected area as indicated on drawings.

1. Install erosion control devices at storm sewer inlets immediately after completion of the storm sewer.

2. Place straw bales in a single row, lengthwise on the contour, and embedded 4 inches into soil.

3. Secure each individual bale in place by stakes or reinforcement bars driven through bales into the ground to a depth of not less than 18 inches.

D. Install inlet protection barriers at curb inlets and at area inlets.

E. Install straw bale fences as ditch checks in drainage ditches.

F. Install Stabilized Construction Access by TxDOT specification 506.4.C.5.

G. Rock filter dams shall be installed so as to prevent downstream deposition of sediment and debris from the construction site. Rock filter dams shall be constructed to meet the following criteria:

1. Type 1:

   a. Non-reinforced.

   b. Height: 18-24 inches

   c. Top width: 2 feet minimum.

   d. Upstream and downstream side slope of dam: 2:1 maximum.

   e. Open graded aggregate 3-5 inches.

2. Type 2:

   a. Reinforced with wire mesh.

   b. Height: 18-36 inches.
   c. Top width: 2 feet minimum.

   d. Upstream and downstream side slope of dam: 2:1 maximum.

   e. Open graded aggregate 3-5 inches.

3. Type 3:
    a. Reinforced with wire mesh.
    b. Height: 36-48 inches.
    c. Top width: 2 feet minimum.
    d. Upstream and downstream side slope of dam: 3:1 maximum.
    e. Open graded aggregate 4-8 inches.
4. Type 4:
    a. Reinforced in a gabion wire basket.
    b. Height: 30 inches minimum.
    c. Top width: 2 feet minimum.
    d. Upstream and downstream side slopes of dam: none specified.
    e. Open graded aggregate 3-5 inches.
5. The separation geotextile fabric and wire mesh shall be sized and placed in accordance with the rock filter dam detail and as specified by the type of rock filter dam shown in the construction plans. The separation geotextile fabric may be omitted only as approved by the Engineer. The separation geotextile fabric and wire mesh shall be securely staked with wooden or metal stakes to the bottom and side slopes of the ditch or channel prior to aggregate placement. Sack gabions for Type 4 rock filter dams shall be securely staked with wooden or metal stakes to the bottom and side slopes of the ditch or channel, as well.
6. Aggregate fill shall be placed to the width, length, height and slopes in accordance with this specification and the rock filter dam detail and as specified by the type of rock filter dam shown in the construction plans. The height of the dam shall be measured vertically from the existing ground to the top of the filter dam. The length of the dam shall be measured across the top centerline of the dam from embankment to embankment and includes the additional length embedded into the embankment. Width of the dam shall be measured along the top face of the dam.
7. Wire mesh shall be folded upstream side over the aggregate fill and tightly secured to itself on the downstream side using wire tires. Hog rings may be substituted for wire ties.
8. Additional aggregate fill or gravel bags shall be placed and secured at the embedded section to prevent low flows from short circuiting the dam at the adjacent dirt embankment area.

9. The Contractor shall be responsible for periodic reshaping, repairing, and maintaining of rock filter dams as directed by the Engineer.

10. The Contractor is responsible for removal and proper disposal of sediment and debris from the rock filter dam. Removing sediment and debris shall not be allowed to flush into the storm sewer system, waterways, jurisdictional wetlands, or onto adjacent properties. Sediment deposits shall be removed before they reach one-third of the height of the dam. Uncontaminated sediment can be placed at the project spoil site or, if properly handled, spread out to supplement fill requirements. If sediment has been contaminated, then it shall be disposed of in accordance with the applicable federal, state, and local regulations. Offsite disposal shall be the responsibility of the Contractor. Contractors are encouraged to reuse aggregate and wire mesh if remaining materials meet original spec requirements.

3.03 EROSION CONTROL SEEDING

A. Exposed fill and stockpile areas shall be protected from windborne erosion if the phasing of the construction operations is anticipated to leave the exposed fill and stockpile areas unattended for 6 weeks or more. At completion of stockpiling operations, stockpiles shall be shaped and graded to drain. Provide a layer of mulch to all sides of the stockpile to protect the stockpile from windborne erosion.

B. Areas designated on the drawings to be seeded shall be seeded in accordance to the Texas Department of Transportation Standard Specifications, Item 164, titled "Seeding for Erosion Control". Broadcast seeding method shall be used as described in TxDOT, Item 164.4 unless otherwise instructed.

C. Areas to be seeded with slopes steeper than 10H:1V shall also utilize a soil retention blanket as specified in TxDOT Item 169 Soil Retention Blanket.

3.04 TEMPORARY SWALES

A. Temporary drainage swales shall be provided as required to carry drainage away from the work area to an approved outfall point.

B. Unless otherwise shown on the drawings, swales shall be earthen "V" shaped channels graded to a sufficient depth and slope to carry the anticipated runoff, but at least two (2) feet deep with a slope of 0.1%.

C. Swales not designated to remain in place at the completion of the contract shall be cleaned of any muck, debris and other unsuitable material and filled with approved fill before final grading operations begin.

D. Swales shall have erosion control barriers as required in these specifications.

3.05 FILL AND CUT SLOPES

A. Fill slopes in all cases shall be no steeper than 3:1 unless specifically stated on the plans or approved by the Owner's Geotechnical engineer.

B. When cut slopes exceed 2:1 for depths over three (3) feet, proper bracing and shoring per OSHA requirements shall be used and maintained.

C. For permanent slopes, cut or fill, between 2:1 and 10:1, erosion protection shall be provided with hydro mulching seeding, sodding, or other method as approved.

D. Where cut slopes of more than 5 feet deep, extending more than 100 feet in length, contractor shall provide a backfill drain at the top of the slope to ease in drainage and erosion control.

3.06 SEDIMENTATION BASINS

A. Sedimentation ponds shall be provided when designated on the plans.

B. All drainage from cleared areas shall be routed through the sedimentation basin.

C. Contractors will be responsible for the operation and maintenance of the pond during construction.

3.07 MAINTENANCE

A. Check all erosion control measures after each rainfall event to ensure that they are in proper working order.

1. Immediately restore all measures to installed condition.

2. During construction all temporary swales constructed for this contract shall be maintained to allow proper drainage from the construction area. Before Contractor leaves the site at the end of construction, all temporary swales must be reworked to meet final conditions as set forth in the drawings and specifications.

3. The Contractor shall ensure that all sub work with other contractors at the site understand the importance of the erosion control features. The Contractor requires all subcontractors to respect the function of the erosion control features and enlist their coordination in maintaining existing swales and ditches.

B. Inspect silt and straw bale fences at least once a week.

1. Immediately replace damaged portions of the silt fences, including portions which have collapsed, contain tears, have decomposed, or have become ineffective.

2. Remove sediment deposits, as necessary, to provide adequate sediment storage and to maintain the integrity of fences. Dispose of accumulated sediment by spreading over upland areas of the site.

C. Maintain erosion control devices in place, as specified, until completion of the work of this Contract.

1. At completion of work, inspect all systems, make necessary repairs, remove and dispose of all accumulated sediment, and turn completely operable systems over to Owner for continued maintenance.

D. Where necessary for equipment and vehicular access to the work areas, adequately sized culverts should be installed and maintained to provide access without disturbing the site drainage.

E. Sedimentation Basins.

1. Contractor shall be responsible for maintaining the pond and the outfall and sediment retarding structure in good working condition throughout the time the pond is to be in operation.

2. When sediment and debris fill the pond to over one third (1/3) its designed capacity, the pond shall be cleaned out.

3. The sediment from the clearing operation shall be stockpiled with like materials per Specification 31 11 00 Clearing and Grubbing. If the material is found to not meet the stockpiling requirements listed in 31 11 00, they must be removed from the site as described in 31 11 00.

3.08 INSPECTIONS

A. Inspect all erosion control systems and devices at least once every seven calendar days.

B. Inspect all erosion control systems and devices within 24 hours of the end of any storm which results in precipitation of 1/2 inch or more.

C. During inspections, locations where stormwater leaves the site shall be inspected for evidence of erosion or sediment deposition.

D. Correct deficiencies within three calendar days.

E. Complete a report of each inspection. Report shall contain the following minimum information:

1. Inspector's name

2. Inspection date

3. Observations of the effectiveness of erosion control systems

4. Actions taken if necessary to correct deficiencies

5. Listing of areas where construction operations have permanently or temporarily stopped

6. Authorized signature

END OF SECTION 31 25 00

SECTION 31 63 29
DRILLED CONCRETE PIERS AND SHAFTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Dry-installed drilled piers.
   2. Slurry displacement-installed drilled piers.
   3. Dry-installed or slurry displacement-installed drilled piers at Contractor's choice.

1.3 UNIT PRICES

A. Unit prices are included in Section 01 22 00 "Unit Prices."

B. Drilled Piers: Actual net volume of drilled piers in place and approved. Actual length, shaft diameter, and bell diameter if applicable, may vary, to coincide with elevations where satisfactory bearing strata are encountered. These dimensions may also vary with actual bearing value of bearing strata determined by an independent testing and inspecting agency. Adjustments will be made on net variation of total quantities, based on design dimensions for shafts and bells.
   1. Base bids on indicated number of drilled piers and, for each pier, the design length from top elevation to bottom of shaft, extended through the bell, if applicable, and the diameter of shaft and bell.

   2. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, testing and inspecting, and other items for complete drilled-pier installation.

C. Trial Drilled Pier: Unit price as indicated for drilled pier, including backfilling.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Shop Drawings: For concrete reinforcement detailing fabricating, bending, supporting, and placing.

D. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.

E. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

F. Field quality-control reports.

G. Other Informational Submittals:

1. Record drawings.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in drilled-pier work.

B. Testing Agency Qualifications: Qualified according to ASTM C 1077, ASTM D 3740, and ASTM E 329 for testing indicated.

C. Drilled-Pier Standard: Comply with ACI 336.1 unless modified in this Section.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.
1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.

B. Interruption of Existing Utilities: Do not interrupt any utility to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify all affected parties including Owner no fewer than five (5) days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Owner's written permission.

C. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for drilled piers.
2. The geotechnical report is referenced elsewhere in the Project Manual.

D. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

1. Record and maintain information pertinent to each drilled pier and cooperate with Owner's testing and inspecting agency to provide data for required reports.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Refer Section 03 20 00.

2.2 CONCRETE MATERIALS

A. Refer Section 03 30 00 and Structural General Notes.

2.3 STEEL CASINGS

A. Steel Pipe Casings: ASTM A 283, Grade C, or ASTM A 36, carbon-steel plate, with joints full-penetration welded according to AWS D1.1.

B. Corrugated-Steel Pipe Casings: ASTM A 929, steel sheet, zinc coated.

2.4 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.

C. Proportion normal-weight concrete mixture as follows:

1. As indicated in Structural General Notes.

2.5 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.6 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.
   1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.

3.2 EXCAVATION

A. Unclassified Excavation: Excavate to bearing elevations regardless of character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.
   1. Obstructions: Unclassified excavation may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. No changes in the Contract Sum or the Contract Time will be authorized for removal of obstructions.
   2. Obstructions: Unclassified excavated materials may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. Payment for removing obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work will be according to Contract provisions for changes in the Work.

B. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.

C. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation.
   1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
   2. Remove water from excavated shafts before concreting.

D. Notify and allow testing and inspecting agency to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Architect.
   1. Do not excavate shafts deeper than elevations indicated unless approved by Architect.
   2. Payment for additional authorized excavation will be according to Contract provisions for changes in the Work.

E. Excavate shafts for closely spaced drilled piers and for drilled piers occurring in fragile or sand strata only after adjacent drilled piers are filled with concrete and allowed to set.

F. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.

1. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete.

G. Bells: Excavate bells for drilled piers to shape, base thickness, and slope angle indicated. Excavate bottom of bells to level plane and remove loose material before placing concrete.

H. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.

1. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit design and construction proposals to Architect for review before proceeding.

3.3 STEEL REINFORCEMENT

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover over reinforcement.

E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.

F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.4 CONCRETE PLACEMENT

A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by Owner's independent testing and inspecting agency.

1. Construct a construction joint if concrete placement is delayed more than one hour. Level top surface of concrete. Before placing remainder of concrete, clean surface laitance, roughen, and slush concrete with commercial bonding agent or with sand-cement grout mixed at ratio of 1:1.

B. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.

1. Where concrete cannot be directed down shaft without striking reinforcement, place concrete with chutes, tremies, or pumps.

2. Vibrate top 60 inches of concrete.

C. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch head of concrete above bottom of casing.

1. Vibrate top 60 inches of concrete after withdrawal of temporary casing.

D. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.

E. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.
1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.

F. If hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no more than 90 deg F.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Drilled piers.
2. Excavation.
3. Concrete.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Drilled-Pier Tests and Inspections: For each drilled pier, before concrete placement.

1. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths and bearing capacities will be determined by testing and inspecting agency. Final evaluations and approval of data will be determined by Architect.

D. Concrete Tests and Inspections: ASTM C 172 except modified for slump to comply with ASTM C 94.

1. Slump: ASTM C 143; one test at point of placement for each compressive-strength test but no fewer than one test for each concrete load.
2. Concrete Temperature: ASTM C 1064; 1 test hourly when air temperature is 40 deg F and below and 80 deg F and above, and 1 test for each set of compressive-strength specimens.
3. Compression Test Specimens: ASTM C 31; one set of four standard 6-inch x 12-inch cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.

4. Compressive-Strength Tests: ASTM C 39; one set for each drilled pier but not more than one set for each truck load. One specimen will be tested at 7 days, 2 specimens will be tested at 28 days, and 1 specimen will be retained in reserve for later testing if required.
5. If frequency of testing will provide fewer than five strength tests for a given class of concrete, testing will be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
6. If strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
8. Report test results in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. List Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests in reports of compressive-strength tests.
9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
10. Additional Tests: Testing and inspecting agency will make additional tests of concrete if test results indicate that slump, compressive strengths, or other requirements have not been met, as directed by Architect.

    a. Continuous coring of drilled piers may be required, at Contractor's expense, if temporary casings have not been withdrawn within specified time limits or if observations of placement operations indicate deficient concrete quality, presence of voids, segregation, or other possible defects.

11. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

E. An excavation, concrete, or a drilled pier will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports for each drilled pier as follows:

1. Actual top and bottom elevations.
2. Actual drilled-pier diameter at top, bottom, and bell.
3. Top of rock elevation.
4. Description of soil materials.
5. Description, location, and dimensions of obstructions.
6. Final top centerline location and deviations from requirements.
7. Variation of shaft from plumb.
8. Shaft excavating method.
9. Design and tested bearing capacity of bottom.
10. Levelness of bottom and adequacy of cleanout.

11. Ground-water conditions and water-infiltration rate, depth, and pumping.
12. Description, purpose, length, wall thickness, diameter, tip, and top and bottom elevations of temporary or permanent casings. Include anchorage and sealing methods used and condition and weather tightness of splices if any.
13. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
14. Bell dimensions and variations from original design.
15. Date and time of starting and completing excavation.
16. Inspection report.
17. Condition of reinforcing steel and splices.
18. Position of reinforcing steel.
19. Concrete placing method, including elevation of consolidation and delays.
20. Elevation of concrete during removal of casings.
21. Locations of construction joints.
22. Concrete volume.
23. Concrete testing results.
24. Remarks, unusual conditions encountered, and deviations from requirements.

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 31 63 29

SECTION 32 13 13
PORTLAND CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for providing, placing, curing and protecting Portland cement concrete paving, with or without reinforcement as indicated, constructed on a prepared subgrade.

1.02 QUALITY ASSURANCE

A. Reference Standards Applicable to this Section

1. ACI: American Concrete Institute

   a. 301: Specifications for Structural Concrete for Buildings.

   b. 316R: Recommendations for Construction of Concrete Pavements and Concrete Bases.

2. ASTM: American Society for Testing and Materials

   a. A 615: Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement (with Supplement + S1).

   b. C 150: Specification for Portland Cement Type I or Type II.

   c. C 309: Specification for Liquid Membrane-Forming pounds for Curing Concrete.

   d. C 881: Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

   e. D 1565: Specifications for Flexible Cellular Materials Vinyl Chloride Polymers and Copolymers (Open-Cell Foam).

   f. D 1751: Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (No extruding and Resilient bituminous Types).

   g. D 1752: Specifications for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

   h. D 3405: Specification for Joint Sealants, Hot-Poured, for Portland Cement Concrete Pavement.

3. TxDOT: Texas Department of Transportation.

   a. Standard Specifications for Construction of Highways, Streets, and Bridges -- Latest Edition.

1) Item 360, CONCRETE PAVEMENT.

B. Formwork Tolerances

Formwork tolerances shall be as specified in ACI 316 R, Chapter 5.

C. Finishing Tolerance

The top surface of pavement shall have a Class B tolerance as specified in ACI 316 R, Chapter 12.5 and ACI 301, Chapter 11.9.

D. The Portland Cement Paving Contractor/Subcontractor shall provide OWNER with evidence of his/her ability to perform the specified work. This evidence shall be in the form of at least five (5) successfully completed Portland Cement paving projects for either the Klein ISD, Harris County, City of Houston, or any combination of the three.

This list of projects shall be submitted to OWNER prior to any paving operations beginning so that OWNER will be able to inspect the quality of workmanship at the site and approve the Contractor/Subcontractor.

1.03 SUBMITTALS

A. In accordance with Section 01 33 00 – Submittal Procedures

1. Reinforcement Materials

a. As required in Section 032100 - Concrete Reinforcement of these Specifications.

2. Concrete Materials

a. As required in Sections 321373.19 - Cast-in-Place Concrete of these Specifications.

3. Joint Materials

a. As required in Section 321319 – Concrete Pavement Joints.

1.04 EXTENDED WARRANTY

A. Manufacturer of joint sealant shall provide at least a 1-year written warranty against material degradation or failure and water and foreign matter infiltration through the joint from the time of written acceptance of the Work. This warranty shall not limit OWNER's rights or remedies as may otherwise be afforded under law or statute.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Forms: Metal forms, as indicated in ACI 316 R, Chapter 5.

B. Welded Steel Wire Fabric: Plain wire fabric, as specified in Section 032100 - Concrete Reinforcement of these Specifications.

C. Reinforcing Steel Bars: As specified in Section 032100 - Concrete Reinforcement of these Specifications.

D. Dowel Bars: Smooth, ASTM A 615 + S1, Grade 60, new billet steel, coated with a water-resistant lubricant immediately prior to placement of concrete in which unbonded ends of bars are to be embedded.

E. Dowel Bar Sleeves: Sleeves, PVC or plastic, slightly larger than dowel bars, closed end, a minimum of 6 in. long, with 1-1/2 in. long compressible insert.

F. Concrete: Class 3000, as specified in Section 321373.19 – Cast-in-Place Concrete of these Specifications.

G. Membrane Forming Curing Compound: ASTM C 309, Type 2, unless otherwise directed.

H. Joint Materials

1. Preformed Expansion Joint Filler: ASTM D 1751, ASTM D 1752, and D 1565.

2. Joint Sealing Material: See Section 321319, Concrete Pavement Joints of these Specifications.

I. Form Coating: Commercial formulation form-coating compounds that will neither bond with stain, nor adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces. Contractor shall submit sample for approval prior to use.

J. Precast Concrete Wheel Stops: Accurately formed and finished, of size and shape as indicated, reinforced, and anchored as required. Fabricate wheel stops on Site or substitute approved precast units of like design and dimensions.

K. Epoxy Bonding Grout: ASTM C 881, Type I.

PART 3 – EXECUTION

3.01 INSPECTION AND PREPARATION

A. Prepared subgrade shall be proof rolled to check for unstable areas and need for additional compaction. Do not begin paving work until such deficiencies have been corrected and subgrade is ready to receive paving.

B. Loose material shall be removed from the compacted subgrade immediately prior to placing concrete and subgrade shall be uniformly dampened.

3.02 SETTING FORMS

A. Forms shall be set in accordance with the recommendations of ACI 316 R, Chapter 5, and as specified herein.

B. Forms shall be set in sufficient quantity to allow continuous progress of concrete placement, and to ensure that forms shall remain in place not less than 24 hours.

C. Forms shall be cleaned after each use and coated with an approved form release agent prior to each use.

3.03 INSTALLATION OF JOINTS, REINFORCEMENT, AND SEALANT

A. Joints and reinforcement shall be installed in accordance with the recommendations of ACI 316 R, Chapter 6, as specified in Section 032100 - Concrete Reinforcement of these Specifications, and in Section 321319 - Concrete Pavement Joints.

B. Sealant manufacturers' instructions and procedures shall be followed so as not to invalidate the warranty.

3.04 PLACING AND FINISHING CONCRETE

A. Concrete shall be placed and finished in accordance with the recommendations of ACI 316 R, Chapters 10 and 12.5, and as specified in Section 321373.19 - Cast-in-Place Concrete of these Specifications.

3.05 3CURING AND PROTECTING CONCRETE

A. Concrete shall be cured in accordance with the recommendations of ACI 316 R, Chapter 11, using the membrane curing method and materials.

B. Protection as recommended in ACI 316 R; Chapter 11 shall be provided until written acceptance by OWNER.

3.06 INSTALLATION OF CONCRETE WHEEL STOPS

A. Install concrete wheel stops were indicated and in accordance with manufacturers' installation instructions as required. Where dowels are to be embedded into concrete, embedded with epoxy bonding grout.

3.07 FIELD QUALITY CONTROL

A. Coring

After the pavement is placed and before final acceptance the Engineer may elect to determine pavement thickness by cores cut from the pavement or direct measurement of the edge thickness. Acceptable pavement thickness shall be deficient by no more than two tenths of an inch. Core holes shall be promptly repaired with concrete conforming to the requirements specified herein by the Contractor at no cost to OWNER.

B. Deficient Pavement Price Adjustments

Where the average thickness of pavement is deficient in thickness by more than 0.2 inch, but not more than 0.75-inch, payment will be made at an adjusted price as specified in the following table.

Concrete Pavement Deficiency

Deficiency in Thickness Determined by Cores	Proportional Part Contract Price

Inches	Allowed
0.00 to 0.20	100 percent
Over 0.20 to 0.30	80 percent
Over 0.30 to 0.40	72 percent
Over 0.40 to 0.50	68 percent
Over 0.50 to 0.75	57 percent

Any area of pavement found deficient in thickness by more than 0.75 of an inch but not more than one inch or 1/8 of the plan thickness, whichever is greater, shall be evaluated by the Engineer. If, in the judgment of the Engineer, the area of such deficiency should not be removed and replaced, there will be no payment for the area retained. If, in the judgment of the Engineer, the area of such deficiency warrants removal, the area shall be removed and replaced, at the Contractor's entire expense, with concrete of the thickness shown on the plans. Deficient pavement shall be removed for the full area of the slab between joints, or between pre-established limits.

END OF SECTION 32 13 13

SECTION 32 13 19
CONCRETE PAVEMENT JOINTS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Joints for concrete paving; concrete sidewalks, concrete driveways, curbs, and curb and gutters.

B. Saw-cutting existing concrete or asphalt pavements for new joints.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for street pavement expansion joints, with or without load transfer, is on linear foot basis.

2. Payment for horizontal dowels is on a unit price basis for each horizontal dowel.

3. No separate payment will be made for formed or sawed street pavement contraction joints and longitudinal weakened plane joints. Include payment in unit price for Concrete Paving.

4. No separate payment will be made for joints for Curb, Curb and Gutter, Saw-tooth Curb, Concrete Sidewalks, and Concrete Driveways. Include payment in unit price for Curb and Gutter, Concrete Sidewalks, and Concrete Driveways.

5. Payment will be made for Preformed Expansion Joints on a linear foot basis only when field conditions require that sidewalk be moved adjacent to existing concrete structure (i.e., street, back of curb, etc.).

6. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement’s D 994 - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).

B. ASTM D 1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (no extruding and Resilient Bituminous Types).

C. ASTM D 3405 - Standard Specification for Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements.

D. TxDOT Tex-525-C - Tests for Asphalt and Concrete Joint Sealers

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit product data for joint sealing compound and proposed sealing equipment for approval.

C. Submit samples of dowel cup, metal supports, and deformed metal strip for approval. Submit manufacturer's recommendation for placing sealant(s).

PART 2 - PRODUCTS

2.01 BOARD EXPANSION JOINT MATERIAL

A. Filler board of selected stock. Use wood for density and type as follows:

1. Clear, all-heart cypress weighing no more than 40 pounds per cubic foot, after being dried in dried to constant weight.

2. Clear, all-heart redwood weighing no more than 30 pounds per cubic foot, after being dried to constant weight.

2.02 PREFORMED EXPANSION JOINT MATERIAL

A. Bituminous fiber and bituminous mastic composition material conforming to ASTM D 994 and ASTM D 1751.

2.03 JOINT SEALING COMPOUND

A. Conform joint sealants to one of sealant classes described in this section.

B. Conform hot-poured rubber-asphalt compound to ASTM D 3405.

C. Two-component Synthetic Polymer.

1. Curing is to be by polymerization and not by evaporation of solvent or fluxing of harder particles.

2. Cure sufficiently at average temperature of 25 ± 1 C (77 ± 2 F) so as not to pick up under wheels of traffic in maximum three hours.

3. Performance requirements, when tested in accordance with TxDOT Tex-525-C, shall meet above curing times and requirements as follows:

Cold-Extruded and Cold-Pourable (Self-Leveling) Specifications	
Property	Requirement
Penetration, 25 C (77 F) 150 g Cone, 5 s, 0.1 mm (in.), maximum	130
Bond and Extension 50%, -29 C (-20 F), 3 cycles: *Dry Concrete Block *Steel blocks (Primed, if recommended by manufacturer) *Steel blocks shall be used when armor joints are specified	Pass Pass
Flow at 70 C (158 F)	None
Water content % by mass, maximum	5.0
Resilience: * Original sample, % min. (cured) * Oven-aged at 70 C (158 F), % min.	50 50
Cold-extruded material only - Cold Flow (10 minutes)	None

After bond and extension test, there shall be no evidence of cracking, separation or other opening that is over 3 millimeters (1/8 inch) deep in sealer or between sealer and test blocks.

4. Provide cold-extruded type for vertical or sloping joints.

5. Provide self-leveling type for horizontal joints.

D. Self-Leveling, Low Modulus Silicone or Polyurethane Sealant for Asphaltic Concrete and Portland Cement Concrete Joints. This shall be a single component self-leveling silicone or polyurethane material that is compatible with both asphalt and concrete pavements. The sealer shall not require a primer for bond; a backer rod shall be required which is compatible with the sealant; no reaction shall occur between rod and sealant.

When tested in accordance with TxDOT Tex-525-C, self-leveling sealant shall meet following requirements:

Self-Leveling, Low Modulus Silicone or Polyurethane Sealant	
Property	Requirements
Tack Free Time, 25 ± 1 C (77 ± 2 F), minutes	120 maximum
Nonvolatile content, % by mass	93 minimum

Tensile Strength and 24-Hour Extension Test: * Initial, 10-day cure, 25 ± 1 C (77 ± 2 F), kPa (psi) * After Water Immersion, kPa (psi) * After Heat Aging, kPa (psi) * After Cycling, -29 C (-20 F), 50%, 3 cycles, kPa (psi) * 24 Hour Extension	* 21 to 69 (3 to 10) * 21 to 69 (3 to 10) * 21 to 69 (3 to 10) * 21 to 69 (3 to 10) * Pass (All Specimens) After 24 hours, there shall be no evidence of cracking, separation or other openings that is over 3 mm (1/8 in.) deep at any point in the sealer or between the sealer and test blocks.

2.04 LOAD TRANSMISSION DEVICES

A. Smooth, steel dowel bars conforming to ASTM A 615, Grade 60. When indicated on Drawings, encase one end of dowel bar in approved cap having inside diameter 1/16 inch greater than diameter of dowel bar.

B. Deformed steel tie bars conforming to ASTM A 615, Grade 60.

2.05 SUPPORTS FOR REINFORCING STEEL AND JOINT ASSEMBLY

A. Employ supports of approved shape and size that will secure reinforcing steel and joint assembly in correct position during placing and finishing of concrete. Space supports as directed by Project Manager.

PART 3 - EXECUTION

3.01 PLACEMENT

A. When new Work is adjacent to existing concrete, place joints at same location as existing joints in adjacent pavement.

B. If limit of removal of existing concrete or asphalt pavement does not fall on existing joint, saw cut existing pavement minimum of 2 inches deep to provide straight, smooth joint surface without chipping, spalling or cracks.

3.02 CONSTRUCTION JOINTS

A. Place transverse construction joint wherever concrete placement must be stopped for more than 30 minutes. Place longitudinal construction joints at interior edges of pavement lanes using No. 6 deformed tie bars, 30 inches long and spaced 18 inches on centers.

3.03 EXPANSION JOINTS

A. Place 3/4-inch expansion joints at radius points of curb returns for cross street intersections, or as located in adjacent pavement but no further than 80 feet apart. Use no boards shorter than 6 feet. When pavement is 24 feet or narrower, use not more than 2 lengths of board. Secure pieces to form straight joint. Shape board filler accurately to cross section of concrete slab. Use load transmission devices of type and size shown on Drawings unless otherwise specified or shown as "No Load Transfer Device." Seal with joint sealing compound.

3.04 CONTRACTION JOINTS

A. Place contraction joints at same locations as in adjacent pavement or at spaces indicated on Drawings. Place smoothed, painted and oiled dowels accurately and normal to joint. Seal groove with joint sealing compound.

3.05 LONGITUDINAL WEAKENED PLANE JOINTS

A. Place longitudinal weakened plane joints at spaces indicated on Drawings. If more than 15 feet in width is poured, longitudinal joints must be saw cut. Seal groove with joint sealing compound.

3.06 SAWED JOINTS

A. Use sawed joints as alternate to contraction and weakened plane joints. Use circular cutter capable of cutting straight line groove minimum of 1/4 inch wide. Maintain depth of one quarter of pavement thickness. Commence sawing as soon as concrete has hardened sufficiently to permit cutting without chipping, spalling or tearing and prior to initiation of cracks. Once sawing has commenced, continue until completed. Make saw cut with one pass. Complete sawing within 24 hours of concrete placement. Saw joints at required spacing consecutively in sequence of concrete placement.

B. Concrete Saw: Provide sawing equipment adequate in power to complete sawing to required dimensions and within required time. Maintain ample supply of saw blades at work site during sawing operations. Maintain sawing equipment on job during concrete placement.

3.07 JOINTS FOR CURB, CURB AND GUTTER

A. Place 3/4-inch performed expansion joints through curb and gutters at locations of expansion and contraction joints in pavement, at end of radius returns at street intersections and driveways, and at curb inlets. Maximum spacing shall be 120- foot centers.

3.08 JOINTS FOR CONCRETE SIDEWALKS

A. Provide 3/4-inch expansion joints conforming to ASTM A 1751 along and across sidewalk at back of curbs, at intersections with driveways, steps, and walls; and across walk at intervals not to exceed 36 feet. Provide expansion joint material conforming to ASTM D 994 for small radius curves and around fire hydrants and utility poles. Extend expansion joint material

full depth of slab.

3.9 JOINTS FOR CONCRETE DRIVEWAYS

A. Provide 3/4-inch expansion joints conforming to ASTM D 1751 across driveway in line with street face of sidewalks, at existing concrete driveways, and along intersections with sidewalks and other structures. Extend expansion joint material full depth of slab.

3.10 JOINT SEALING

A. Seal joints only when surface and joints are dry, ambient temperature is above 50 degrees F and less than 85 degrees F and weather is not foggy or rainy.

B. Use joint sealing equipment in like new working conditions throughout joint sealing operation and be approved by Project Manager. Use concrete grooving machine or power-operated wire brush and other equipment such as plow, brooms, brushes, blowers or hydro or abrasive cleaning as required to produce satisfactory joints.

C. Clean joints of loose scale, dirt, dust and curing compound. The term joint includes wide joint spaces, expansion joints, dummy groove joints or cracks, either preformed or natural. Remove loose material from concrete surfaces adjacent to joints.

D. Fill joints neatly with joint sealer to depth shown. Pour sufficient joint sealer into joints so that, upon completion, surface of sealer within joint will be 1/4 inch above level of adjacent surface or at elevation as directed.

3.11 PROTECTION

A. Maintain joints in good condition until completion of Work.

B. Replace damaged joints material with new material as required by this Section.

END OF SECTION 32 13 19

SECTION 32 13 73.19
SITEWORK CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.01 DESCRIPTION

A. This Section includes furnishing materials and installation of cast-in-place concrete as indicated on the Drawings and/or specified herein.

B. Full cooperation shall be given to other trades to install embedded items. Suitable templates insert and sleeves shall be provided for setting items not placed in the forms.

C. All concrete work shall conform to the requirements of ACI 318-95 and CRSI Standards, unless specifically noted otherwise.

1.02 QUALITY ASSURANCE

A. Prior to starting concrete operations, the Contractor shall name his source of supply for concrete materials and shall submit representative samples and reports of quality tests for approval.

B. The Contractor will engage the services of a recognized independent testing laboratory, approved by the Owner, to perform the following services, (in accordance with ASTM E 329-77) the cost of which shall be paid by the Contractor:

1. Design the concrete mixtures specified, make quality tests of materials, inspect the proportioning and mixing of all concrete for this project.

2. Slump Test, ASTM C-143, shall be taken as often as required to provide the specified consistency to concrete.

3. Cast and test of at least 6 cylinders for each day's pour or for each 100 cubic yards or fraction thereof. Cylinders shall be cured and tested in accordance with ASTM specifications for control tests. Cylinders shall be tested on 7 and 28 days. The Contractor shall provide insulated storage room with heat when necessary to store control cylinders, and a protected, fenced-in space for storage of field cylinders, which approximates the condition of curing of the concrete being sampled.

C. In the event that concrete fails to meet strength requirements of these Specifications, the Engineer may require at no additional cost to the Owner, tests in accordance with the "Standard Methods of Securing, Preparing and Testing Specimens of Hardened Concrete for Compressive and Flexural Strengths", ASTM C42, or order load tests in accordance with Chapter 20 of the ACI Building Code 318-95, to be made on the portions of the structure containing questionable concrete. Suitable appliances and methods of loading and measuring shall be provided by the Contractor. The portions of the structure which are found by the Architect/Engineer to contain defective concrete shall be removed and reconstructed in a satisfactory manner at the Contractor's expense. Concrete strength tests are to conform to Chapter 4 of the ACI Building Code 318-95.

D. The laboratory shall have free access to material stockpiles, batching and mixing plants, and job site. The Contractor shall provide adequate assistance to the laboratory in securing specified samples for tests.

E. Contractor shall give the Owner and laboratory reasonable notice before beginning any pours (at least 24 hours).

F. The laboratory shall supply a daily report of concrete and materials testing and inspection to the Architect, Engineer, Design/Builder, Contractor and Owner.

G. Concrete batched away from the job and delivered in mixer or agitator trucks shall conform to requirements of ASTM C94.

H. Authority and Duties of Laboratory Personnel: Inspectors shall inspect the materials and the manufacture of concrete as specified and shall report to the Owner's Representative, Contractor, Architect and the Engineer the progress thereof. Also, when it appears that the material furnished and the work performed by the Contractor fail to fulfill the specification requirements and contract, the inspector shall direct the attention of the Contractor to such failure or infringement. Such inspection shall not relieve the Contractor of any obligation to furnish acceptable materials or to provide the concrete quality in the structure that is in strict accord with plans and specifications. The inspector are not authorized to revoke, alter, relax, enlarge, or release any portion of the work, but in case of any dispute arising between the inspector and the Contractor as to materials furnished or in the manner of performing the work the inspector shall have the authority to reject materials or suspend the work until the question at issue can be referred to the Engineer. The inspector shall not act as foreman or perform other duties for the Contractor. In no case shall any advice or omission on the part of the inspector relieve the Contractor of responsibility for completing the work in accordance with the plans and specifications and the fulfillment of the contract. The work will be inspected as it progresses, but failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered or obligate the Engineer for final acceptance. Any expense incidental to the investigation and determination of actual quality of any questionable material shall be borne by the Contractor.

I. Sampling and Testing:

1. All materials shall be sampled, tested in accordance with appropriate ASTM Standards, and approved before inclusion in any work on this project.
2. Samples for testing shall be furnished by the Contractor.
3. Rejected material shall be immediately removed from the site.
4. Reinforcing steel shall be tested by heat in shops and by random sampling in the field when required by the Architect/Engineer or Owner.

1.03 SUBMITTALS

A. Shop Drawings: The Contractor is to include as a part of his expense the cost of completely dimensioned concrete shop drawings embracing plans and details, bending diagrams, steel order list, placing diagrams, which service shall be furnished by a structural engineer licensed in the State of the project. No portion of the contract documents shall be reproduced and submitted as shop drawings. The shop drawings shall include the following:

1. Necessary Floor Plans – fully dimensioned plans with all depressions, rises, reinforcing steel, to include placement and accessories.

2. Miscellaneous Items – All other reinforced concrete items shall be drawn at such scale as to give full dimensions, details and reinforcing with accessories as required.

B. All reinforcing shall be detailed, ordered, and fabricated in accordance with the latest ACI Manual of Standard Practice for Detailing Concrete Structures and the CRSI Manual of Standard Practice.

C. Submit Shop Drawings to the Architect for review, prior to release to field. Fabrication of reinforcing steel shall not be started until Drawings have been reviewed and stamped.

D. Prior to the placement of any concrete, design mixes for each type of concrete shall be submitted and approved by the testing laboratory. Mix designs shall include all required and shall include each type of aggregate and admixture to be used.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Concreting shall not be started during rain, sleet or snow and shall not be continued during such weather after having been started except long enough to come to a suitable cutoff point. Concrete placed during rain shall have the cement content increased in the amount of one sack of cement per cubic yard of concrete. All forms and earth forms shall be free of ice and frozen surfaces.

B. No concrete shall be poured unless temperature is 40 degrees and rising or unless special precautions are taken (approved by the Architect). Adequate equipment shall be provided for heating the concrete materials and protecting the concrete during freezing and near freezing weather. All concrete should have a temperature of between 50 degrees and 90 degrees F when depositing and should be maintained within this temperature range for at least 72 hours or for as much time as is required to ensure the proper rate of curing. No salt or other chemicals should be added to prevent freezing. The covering or other method used for temperature protection shall remain in place 24 hours after artificial heat is discontinued. The recommended Practice for Cold Weather Concreting" (ACI 306) and the "Recommended Practice for Hot Weather Concreting" (ACI 305) shall be accepted as good practice.

PART 2 – PRODUCTS

2.01 MATERIALS

A. All materials shall be subject to approval. Any change of materials specified shall be submitted for approval and such change, if acceptable, shall be used only when specifically authorized in writing.

B. Cement shall conform to the following specifications:

1. Coarse and fine aggregate shall conform to requirements of ASTM C33 or Federal Specification SS-S-281a.
2. All coarse aggregates shall be crushed limestone.

3. The maximum size of coarse aggregate shall not be larger than 1", 1/5 of the narrowest dimension between forms of the member for which the concrete is to be used, nor larger than ¾ the minimum clear spacing between reinforcing bars. Coarse aggregate for all concrete exposed to the weather shall be crushed limestone with a #57 gradation.
4. Absorption in coarse aggregate shall not exceed 5%.
5. The fineness modulus for fine aggregate used shall not vary more than 0.2 from the approved sample without approval. Fineness modulus to be 2.9.

C. All concrete shall be normal weight unless specifically noted otherwise.

1. Normal weight concrete shall be approximately 145 to 155 pounds per cubic foot.
2. Lightweight concrete shall not exceed 110 pounds per cubic foot and shall be made of normal and normal weight fines.

D. Water shall be clean, fresh, and free from injurious amounts of oils, acids, alkali or organic material or other substances that may be deleterious to concrete or steel.

E. Non-shrink grout shall be factory pre-mixed non-shrink; non-metallic grout containing mineral aggregate and shall require only the addition of water at the site. Grout shall be "EUCO NS" (non-metallic) as manufactured by the Euclid chemical company. "Master flow 713" (non-metallic) as manufactured by Master Builders or approved equal. The grout shall conform to ASTM C-1107 and CRD-621, "Corps of Engineers Specifications for Non-Shrink Grout," and shall be tested in accordance with ASTM C827.

F. Water stops shall be 9" Dumbbell type, Model No. 751 as manufactured by green streak, at locations shown on drawings.

2.02 QUALITY AND PROPORTIONING

A. It shall be the Contractor's responsibility to furnish concrete which will conform to the quality and strength specified.

B. Strengths, unless otherwise indicated on plans or in specifications or in the table below, shall be 3000 psi minimum 28-day compressive strength.

1. Exterior Concrete 4000 psi

C. Proportioning shall follow the limiting factors in the following table:

1. Proportioning based on field experience shall conform to Section 5.3 of ACI 318-89 or the maximum water/cement ratio in Section 5.4 of ACI 318-89.

D. Proportioning and design mixes shall be established to produce average strengths higher than specified by the amounts specified in Chapter 5 of ACI 318-95.

E. Admixtures:

1. Calcium Chloride shall not be used.

2. An approved air-entraining agent (ASTM C260) shall be added at the mixer with accurate dispenser to produce entrained air 4-6% by volume in all concrete subject to weathering conditions.

3. An approved water-reducing agent equal to those manufactured by mixer with an accurate dispenser.

4. These and other admixtures shall be used only with specific approval. Tests for design mixes shall be made with the admixtures included.

5. Fly ash shall not be permitted.

F. The concrete shall be of such consistency and composition that it can be worked readily into the corners and angles of the forms and around reinforcement without permitting materials to segregate or free water to collect on the surfaces. Within the limiting requirements the Contractor shall adjust the consistency of the concrete as may be necessary to produce mixtures which will be placeable with reasonable methods of placing and compacting. The Contractor shall always maintain on the job adequate extra cement to be used at the rate of ½ sack cement per cubic yard concrete for each 2" slump increase for corrections due to wetness desired or obtained. No water shall be added to concrete except under the direct supervision of the engineer or his appointed representative. Under no circumstances will the addition of more than 2 gallons of water per cubic yard of concrete be allowed at the site.

G. Measurement of Materials:

1. Cement shall be measured by the sack or half-sack unless cement is weighed for each batch.

2. Aggregates shall be proportioned separately by weight with proper compensation for weight of moisture; weighing equipment shall be accurate within 1%.

3. Water shall be measured by an approved device capable of accurate measurement to one pint.

H. Concrete shall be from a single source for each major pour.

2.03 REINFORCEMENT

A. Refer to Section 032100 for requirements for reinforcement.

2.04 EXPANSION MATERIALS

A. Verify compatibility of joint filler with sealant specified.

B. All expansion joints on grade shall be pre-formed non-extruding resilient type, bituminous or bonded cork (ASTM D994 or ASTM D1751).

C. Other expansion joints may comply with ASTM D1752 – “Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.” Manufacturer’s certification and material submittal are required.

2.05 CURING, SEALING AND HARDENING COMPOUNDS

A. Liquid Curing and Sealing Compounds – General requirements

1. Curing Compounds: Comply with ASTM C 309, Type 1, Class B.

   a. Non-yellowing formulation was subject to ultraviolet light.

   b. Curing and Sealing Compound: Where indicated, providing curing and sealing formulation with long-lasting finish that is resistant to chemicals, oil, grease, deciding salts, and abrasion.

2. Curing and Hardening Compound: Free of waxes, resins or oils; meet water retention requirements of ASTM C 309; penetrate concrete to change free lime to calcium silicate forming a permanently dense, hard surface.

3. The curing compound shall have test data from an independent laboratory indicating a maximum moisture loss of 0.030 grams per square cm. When applied at a coverage rate of 300 square feet per gallon. Manufacturer’s certification is required.

   a. Provide L&M “dress & Seal 30” or Master Builders “Master seal 66.”

   b. Dissipating Resin Curing Compound: The compound shall be a dissipating resin type compound, conforming to ASTM C309, Type I, “Kurez DR” by The Euclid Chemical Company or approved equal. The film must chemically break down in a two-to-four-week period after application.

4. Curing compounds shall not be used on any surface against which additional concrete or other cementitious material are to be bonded.

2.06 VAPOR RETARDERS (BARRIERS)

A. An approved vapor barrier shall be placed as called for in the Contract Documents. Supply a vapor barrier that complies with one of the following:

1. ASTM E 1745, Class A: A three-ply, nylon- or polyester-cord reinforced, high-density polyethylene sheet; laminated to a nonwoven geotextile fabric, 30 mil (0.76 mm) thick.

2. ASTM E 1745, Class B: A five-ply nylon- or polyester cord-reinforced, high-density polyethylene sheet; 10 mils (0.25 mm) thick.

3. ASTM E 1745, Class C: One of the following materials, or polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick:

   a. Nonwoven, polyester-reinforced, polyethylene coated sheet; 10 mils (0.25 mm) thick.

b. Three-ply, nylon- or polyester-cord-reinforced, laminated, high-density polyethylene sheet; 7.8 mil (0.18 mm) thick.

4. Submittal is required.

PART 3 – EXECUTION

3.01 INSPECTION

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to the proper and timely completion of the Work. Do not proceed until satisfactory conditions have been corrected.

3.02 CONDUITS, HANGERS, SUPPORTS, ANCHORS, ETC.

A. The Contractor shall see that all necessary bolts and anchors of all other trades employed on this structure including conduits, sockets, inserts, sleeves, etc., will be placed by their respective trades or shall himself place them to details before concreting a given section of work. He shall see that these items do not interfere with the reinforcement.

B. No aluminum conduit or product containing aluminum or any other material detrimental to concrete shall be embedded in concrete.

C. All openings in slabs, beams, columns, and footings, which are not shown on the structural plans, must be approved by the Engineer. The maximum diameter of embedded pipes or conduit shall be 1/3 times the slab or wall thickness. The minimum center-to-center spacing of embedded pipes or conduits shall be three times the outside diameter. For pipes or conduits of different diameters, the minimum edge-to-edge spacing shall be two times the smaller diameter.

D. All pipes and conduits providing flow able material conveyance which penetrate beams, footings, or walls shall be provided with sleeves of an appropriate size and material to provide movement for expected settlements or deflections.

3.03 PREPARATION

A. Concrete placing shall not be started until all necessary preparations have been completed and approval has been given. Preparations shall consist of completing available on the job site for heating and/or protecting the concrete whenever freezing temperatures all form work involved, placing all reinforcing steel, pipes, conduits, sleeves, hangers, anchors, fastening devices, waterproofing and such other work to be built into the concrete in the section to be poured, and any other preparations herein required for the concreting operations. Free water and any mud or debris shall be removed from forms and excavations to be occupied by concrete. Approved equipment shall be likely to occur within the curing period. Ice or chilled water may be required to control concrete temperature in hot weather to below 90 degrees F.

B. Slabs-on-grade shall be placed on a properly leveled and thoroughly compacted sub grade, equal to 93% maximum dry density. All subsoils for slabs shall be approved before placing concrete.

C. Approved equipment shall be provided for heating concrete materials and/or protecting the concrete whenever freezing temperatures are likely to occur within curing period.

3.04 INSTALLATION

A. Concrete shall be conveyed from the mixer or transporting vehicle to the place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of materials or displacement of the reinforcing steel, and which will avoid rehandling. For ready-mix concrete in an agitator truck, the elapsed time from mixer to placement shall not exceed 1-1/2 hours.

B. Concrete shall be deposited as nearly as practicable in its final position and shall have the qualities required. Concrete shall be deposited continuously in layers or sections of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause seams or planes of weakness. If sections cannot be placed continuously, proper construction joints shall be provided.

C. Concrete during and immediately after depositing shall be thoroughly compacted and worked around reinforcing and embedded fixtures and into all parts of forms by means of spades, rods and approved mechanical vibrators. For thin walls or inaccessible portions, concrete shall be worked into place by vibrating or other approved method: Care shall be taken so as not to work concrete to the point where segregation occurs.

3.05 CONSTRUCTION AND CONTROL JOINTS

A. All horizontal and vertical construction joints shall be intentionally roughened to a full ¼" ± amplitude or have a continuous 2"x 4" keyway along the joint at contractor's option.

B. Provide reinforcing dowels to match the member reinforcing at the joint, unless noted otherwise.

C. Unless indicated otherwise, slabs-on-grade shall have construction or control joints spaced not to exceed 30 times the slab thickness in any direction. All discontinuous control or construction joints shall be reinforced with two (2) #4 x 48". See structural details. Construction joints shall not exceed 15'-0" O.C. in any direction.

D. Control joints shall be installed in slabs-on-grade so the length-to-width ratio of the slab is not more than 1.25:1. Control joints shall be completed within 12 hours of concrete placement. Control joints may be installed by:

1. Saw Cut to a depth of ¼ the thickness of the slab.
2. Tooled joints shall be made to a depth of ¼ the thickness of the slab.

E. Control joints in visually exposed walls, unless noted otherwise (shall line up with masonry and architectural joints, see drawings):

1. Vertical control joints at 10'-0" O.C.
2. Reinforcing shall be continuous through control and construction joints, unless noted otherwise.
3. Control joints in foundation walls shall line up with masonry control joints.

F. Control joints shall be installed in suspended slabs over steel decking by saw cutting along all interior grid lines. Joints centered above the purlins shall be ¾" deep and shall have #4x5'-0" at 16" O.C. reinforcing placed perpendicular to (and centered on) the purlin. Joints centered

above the girders shall be ¾" deep and shall have #4x16'0" O.C. reinforcing placed perpendicular to (and centered on) the girder. The #4 bar reinforcing centered above the grid lines shall be in addition to the specified WWF, which is continuous throughout the suspended slabs over steel decking. Reinforcing shall be placed 1" below the top of the slab.

3.06 FINISHING

A. Rough Form Finish: For formed concrete surfaces not exposed-to-view in the finish work or by other construction, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding ¼" in height rubbed down or chipped off.

B. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or surfaces that are covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, damp proofing, painting or other similar system. This is as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed.

C. Smooth Rubbed Finish: Provide smooth rubbed finish to scheduled concrete surfaces, which have received smooth form finish treatment, not later than one day after form removal. Moisten concrete surfaces and rub with carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets surfaces occurring adjacent to formed surfaces, strike-off smoothly and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

E. Scratch Finish: Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, terrazzo, stone and other bonded applied cementitious finish flooring material, and as otherwise indicated. After placing slabs, plane surface to a tolerance not exceeding ½" in 10' when tested with a 10' straightedge. Slope surfaces uniformly to drains where required. After leveling; roughen surface before final set, with stiff brushes, brooms or rakes.

F. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, and as otherwise indicated. After screening, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Check and level surface plane to a tolerance not exceeding ¼" in 10' when tested with a 10' straightedge. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth granular texture.

G. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, paint or other thin film finish coating system. After floating, begin final trowel finish operation using a power-driven trowel. Begin final troweling

when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8" in 10' when tested with a 10' straightedge. Grind smooth surface defects, which would telegraph through applied floor covering system.

H. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect and Owner's Representative before application. See Section 321613 – Concrete Curbs and Curb and Gutter.

I. Chemical-Hardener Finish: Apply chemical-hardener finish to interior concrete floors where indicated. Apply liquid chemical-hardener after complete curing and drying of the concrete surface. Dilute liquid hardener with water and apply in 3 coats; first coat, 1/3-strength; second coat, ½-strength; third coat, 2/3-strength. Evenly apply each coat and allow 24 hours for drying between coats. Apply proprietary chemical hardeners, in accordance with manufacturer's printed instructions. After final coat of chemical hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

3.07 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Architect. Cut out honeycomb, rock pockets, voids over ¼" in any dimension, and holes left by tie rods and bolts, down to solid concrete but, in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water and brush coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.

B. For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

C. Repair of Formed Surfaces: Remove and replace concrete having defective surface if defects cannot be repaired to satisfaction of Architect. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surface; and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry pack mortar, or precast cement cone plugs secured in place with bonding agent.

D. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

E. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plant to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having required slope.

F. Repair finished unformed surfaces that contain defects, which affect durability of concrete. Surface defects, such, include crazing, cracks more than 0.01" wide or which penetrate to reinforcement of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.

G. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.

H. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out low areas and replacing them with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Architect.

I. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least ¾" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same material to provide concrete of same type or class as original concrete. Place, compact and finish to blend with adjacent finish concrete. Cure in same manner as adjacent concrete.

J. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Grove top of cracks and cut-out holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry pack, consisting of one-part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry pack after bonding compound has dried. Compact-dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours. Use epoxy-based mortar for structural repairs, where directed by the testing laboratory.

K. Repair methods not specified above may be used, subject to acceptance of Architect.

3.08 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting; keep continuously moist for not less than 7 days. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.

B. Curing Methods: Perform curing of concrete by moist curing, by moisture-retaining cover curing, by curing compound, and by combinations thereof, as herein specified.

C. Provide moisture curing by following methods:

1. Keep concrete surface continuously wet by covering with water.
2. Continuous water-fog spray.
3. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.

D. Provide moisture-cover as follows:

1. Cover concrete surfaces with moisture retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3” and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

E. Provide curing compounds to slabs as follows:

1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer’s directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

2. Do not use membrane curing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, damp proofing, membrane roofing, flooring, painting, and other coatings and finish materials, unless otherwise acceptable to Architect.

F. Curing Formed Surfaces: Cure formed concrete surfaces, by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

G. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of appropriate curing compound. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.

3.09 MISCELLANEOUS

A. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

END OF SECTION 32 13 73.19

SECTION 33 05 16
UTILITY STRUCTURES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Excavation and backfill.

B. Cast-in place concrete structures.

C. Precast concrete structures.

D. Metal components.

1.02 RELATED SECTIONS

A. Concrete formwork, concrete reinforcement, cast-in-place concrete, Portland cement concrete, concrete repair and finishing, and precast concrete are specified in the various Sections under Division 3 - Concrete.

B. Interior trench drains and gratings for interior uses are specified in Section 05 50 00 - Metal Fabrication.

C. Duct banks are specified in Section 20 50 16 - Underground Ductwork and Structures for Facility Services.

1.03 MEASUREMENT AND PAYMENT

A. General: Measurement and payment for utility structures will be either by the lump-sum method or by the unit-price method as determined by the listing of the bid item for utility structures indicated in the Bid Schedule of the Bid Form.

B. Lump Sum: If the Bid Schedule indicates a lump sum for utility structures, the lump-sum method of measurement and payment will be in accordance with Section 01 20 00 - Price and Payment Procedures, Article 1.03.

C. Unit Price: If the Bid Schedule indicates a unit price for utility structures, the unit-price method of measurement and payment will be as follows:

1. Measurement:

a. Cast-in-place concrete and precast concrete units or structures and metal curb-and-gutter inlets will be measured for payment by the individual unit (each), installed in place. Each different type and size of concrete unit or structure will be measured separately for payment.

b. Manhole covers and frames, grates and frames, pipe inlets and outlets, manhole steps, ladders, miscellaneous metal, reinforcing steel, and grounding will not be measured separately for payment, but will be included as part of the utility structure to which it is attached or embedded.

c. Excavation and backfill for utility structures will be measured separately for payment as specified in Section 31 00 00 - Earthwork, as applicable.

2. Payment:

a. Utility structures will be paid for at the indicated Contract unit prices for the computed quantities as determined by the measurement method specified in Article 1.03.C.1, herein.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM A36/A36M Specification for Structural Steel

2. ASTM A48 Specification for Gray Iron Castings

3. ASTM A108 Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality

4. ASTM A123 Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

5. ASTM A153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

6. ASTM A536 Specifications for Ductile Iron Castings

7. ASTM B3 Specification for Soft or Annealed Copper Wire

8. ASTM B26/B26M Specification for Aluminum-Alloy Sand Castings

9. ASTM C33 Specification for Concrete Aggregates

10. ASTM C150 Specification for Portland Cement

11. ASTM C260 Specification for Air-Entraining Admixtures for Concrete

12. ASTM C270 Specification for Mortar for Unit Masonry

13. ASTM C478 Specification for Precast Reinforced Concrete Manhole Sections

14. ASTM C618 Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

15. ASTM C789 Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers

16. ASTM C850 Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 feet of Cover Subjected to Highway Loadings

17. ASTM C858 Specification for Underground Precast Concrete Utility Structures

18. ASTM C891 Practice for Installation of Underground Precast Concrete Utility Structures

B. Underwriters Laboratories Inc. (UL):

1. UL 467 Grounding and Bonding Equipment

1.05 SUBMITTALS

A. General: Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.

B. Shop Drawings: When not indicated on the Contract Drawings in sufficient detail or definition, submit detailed drawings of cast-in-place and precast concrete utility structures and related metal work.

C. Product Data: Submit manufacturers' product data for standard manufactured precast concrete utility boxes and structures and for metal gratings and covers and other, related miscellaneous metal items.

D. Certification: Submit certification or other acceptable evidence that covers and grates to be provided for roadways and parking areas meet proof-testing requirements for H2O and HS2O loadings in accordance with TXDOT’s Bridge Design Specifications Manual.

PART 2 – PRODUCTS

2.01 CAST-IN-PLACE CONCRETE STRUCTURES

A. Materials: Comply with requirements of Section 32 13 13 - Portland Cement Concrete, except as specified otherwise herein.

1. Portland Cement: ASTM C150, Type II, low alkali.

2. Cementitious Admixture: Provide fly ash or pozzolan conforming with ASTM C618, Class F or N, not to exceed 15 percent by weight of the cement content.

3. Aggregates: ASTM C33, fine aggregate and Size Nos. 56 or 57 (1-inch maximum size) coarse aggregate.

B. Mix Design: Obtain design of concrete mix as specified in Section 32 13 13 - Portland Cement Concrete, and incorporate the following requirements:

1. Concrete Strength: Class 4000 minimum in accordance with Table 03305-A of Section 32 13 13 - Portland Cement Concrete, except that electrical structures, such as vaults, pull boxes, and concrete for duct banks, shall be Class 3000.

2. Maximum water-cement plus pozzolan ratio: 0.45.

3. Maximum slump: 4 inches.

2.02 PRECAST CONCRETE STRUCTURES

A. General: The Contractor may provide precast concrete structures that conform to the general configuration, capacities, and inverts indicated.

B. Fabrication Standards: Comply with requirements of Section 03 40 00 - Precast Concrete, and ASTM C478, ASTM C789, ASTM C850, and ASTM C858, as applicable, and applicable manufacturers' standards.

C. Materials: Comply with requirements of Section 03 21 00 - Concrete Reinforcing, Section 32 13 13 - Portland Cement Concrete, and Section 03 40 00 - Precast Concrete, except as specified otherwise herein. Provide fine and coarse aggregates conforming to ASTM C33, in size commensurate with structure and reinforcement clearances.

D. Portland Cement Concrete: Class 4000 minimum in accordance with Table 03305-A of Section 32 13 13 - Portland Cement Concrete. Concrete may be polymer or latex modified to achieve higher strengths and denser concrete. Concrete shall not deteriorate from chemical attack of sanitary waste.

1. Concrete for electrical utility structures shall be Class 3000.

E. Precast Covers: Precast covers shall have the utility identification, such as "PG&E Gas Valve," stamped into the cover.

F. Quality Control: In accordance with Section 01 45 00 - Quality Control, the Contractor shall perform such inspections and tests as required to verify compliance with these Specifications.

2.03 METAL COVERS, GRATES, AND INLETS

A. Ferrous Castings:

1. Metal used in manufacture of castings shall conform to ASTM A48, Class 35B for Gray Iron, or ASTM A536, Grade 65-45-12 for Ductile Iron.

2. Castings shall be of uniform quality, free from blowholes, shrinkage, distortion or other defects. Castings shall be smooth and cleaned by shotblasting.

3. Minimum tensile strength shall be 35,000 psi.

4. Castings shall be manufactured true to pattern; component parts shall fit together in a satisfactory manner. Round frames and covers shall have continuously machined bearing surfaces to prevent rocking and rattling.

5. Where castings will be subjected to loads of H2O or greater, as indicated, provide ductile iron castings.

B. Aluminum Castings: Where required to reduce weights of larger covers for ease of handling, such covers may be manufactured of aluminum castings conforming to ASTM B26/B26M, Alloy No. 713.0. Minimum tensile strength shall be 32,000 psi.

C. Manhole Covers: Provide cast, manufactured manhole covers and frames with heavy-duty solid cover (lid) or vented cover (lid) as indicated. Covers shall be embossed or engraved with nonslip diamond or square cross-hatched pattern. Provide covers with embossed or engraved word identification, as indicated or appropriate, for the enclosed or underground utility.

D. Grates:

1. Cast Ferrous Grates: Grates for area drains and catch basins shall be heavy-duty, bicycle safe inlet grates and frames of size and configuration indicated. Grates in roadways and parking areas shall withstand H20 loadings when proof-tested in accordance with TXDOT's Bridge Design Specifications Manual.

2. Bar-Type Steel Grates: Refer to Section 05 50 00 - Metal Fabrications, for requirements. Bar-type steel gratings will be permitted only in areas where vehicular traffic will not be encountered.

E. Curb and Gutter Inlets: Provide cast, manufactured curb inlet frame, grate, and curb box of size and configuration indicated. Curb and gutter inlets shall conform to the contour and profile of the concrete curb and gutter. Grates shall be heavy-duty and bicycle-safe and shall withstand H20.

F. Cast Iron Manhole Steps: Provide cast, manufactured manhole steps with cross-hatched treads and with anchor configuration appropriate for cast-in-place concrete or precast concrete as indicated. Provide steps for installation 12 inches on center in vertical alignment.

2.04 MISCELLANEOUS METAL

A. Requirements: Provide channel inserts, pulling eyes, ladders, and electrical grounding rods for electrical manholes and pull boxes as indicated.

B. Steel Materials: Standard structural sections, shapes, plates, bars, and rods, as indicated, conforming with ASTM A36/A36M. Bars conforming with ASTM 108 will be acceptable.

C. Anchors and Bolts: Conform with requirements of Section 05 50 00 - Metal Fabrications, as applicable. Bolts and studs, nuts, and washers shall be hot dip galvanized in accordance with ASTM A153.

D. Ladders: Provide standard-manufactured or custom-fabricated steel ladders as required to meet the conditions indicated. Steel ladders shall be hot dip galvanized after fabrication.

E. Grounding and Bonding Materials: Conform with UL 467 and the following requirements:

1. Grounding Rods: Medium carbon steel core, copper-clad by the molten weld casting process, 3/4-inch diameter by 10 feet long in size.

2. Bare Conductors: ASTM B3, No. 1/0 AWG, Class B stranded, annealed copper conductor.

F. Fabrication: Form and fabricate the work as indicated. Include anchors, fasteners, and accessories to anchor and secure the work in place.

G. Galvanizing: All ferrous metal items shall be galvanized after fabrication by the hot-dip process in accordance with ASTM A123. Weight of the zinc coating shall conform with the requirements specified under "Weight of Coating" in ASTM A123.

2.05 MORTAR

A. Cement mortar for the sealing of openings for pipe penetrations, for cementing of joints of component parts of precast structures, for providing of flow characteristics for the bottoms of drainage structures, and other features as indicated shall conform with the Texas Building Code.

B. Mortar shall comply with applicable requirements of ASTM C270, including measurement, mixing, proportioning, and water retention. Ten percent by volume of the cement content of the mortar shall be fly ash or pozzolanic material conforming with ASTM C618.

C. Use mortar within 90 minutes after mixing. Discard mortar that has been mixed longer or that has begun to set. Re-tempering of mortar will not be permitted.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Requirements: Construct manholes, junction chambers, catch basins, curb and gutter inlets, trench drains, culverts, headwalls, wingwalls, pull boxes, utility boxes and vaults, and related utility structures in connection with the installation of pipe, conduits, duct banks, and utility trenches, as indicated.

B. Excavation and Backfill: Provide excavation, prepared subgrade and aggregate base, and backfill as specified in Section 31 00 00 - Earthwork, Section 33 05 28 - Trenching and Backfilling for Utilities, Section 32 11 17 - Aggregate Subbase Courses, and Section 32 11 23 - Aggregate Base Course, as indicated.

C. Cast-in-Place Concrete Structures: Provide formwork, steel reinforcement, and concrete in accordance with applicable requirements of Section 03 11 00 - Concrete Forming, Section 03 21 00 - Concrete Reinforcing, and Section 321373.19 - Cast-In-Place Concrete.

D. Precast Concrete Structures: Install as indicated. Comply with applicable requirements of ASTM C891. Provide such appurtenances and installation accessories, including cement mortar and sealants, as required for a complete installation.

E. Metal Components: Install manhole covers, grates and frames, curb and gutter inlets, metal steps, ladders, channel inserts, pulling eyes, and electrical grounding rods as indicated and in accordance with the respective manufacturer's instructions. Covers and grates in roadways, parking areas, and concrete walks shall be installed flush with adjacent, abutting pavement.

3.02 FIELD QUALITY CONTROL

A. The Contractor shall perform slump tests and strength tests of cast-in-place structures in accordance with the requirements specified in Section 32 13 13 - Portland Cement Concrete.

B. Acceptance of cast-in-place structures will be in accordance with Section 32 13 13, Portland Cement Concrete.

END OF SECTION 33 05 16

SECTION 33 05 28
TRENCHING AND BACKFILLING FOR UTILITIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Excavation, trenching, foundation, embedment, and backfill for installation of utilities, including manholes and other pipeline structures.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices

1. No additional payment will be made for trench excavation, embedment and backfill under this Section. Include cost in unit price for installed underground piping, sewer, conduit, or duct work.

2. When Project Manager directs Contractor to over excavate trench bottom, Contractor will be paid by unit price bid per linear foot under bid item - 6-inches Over Excavation of Trench Bottom.

   a. No payment will be paid if Project Manager does not direct Contractor to over excavate trench bottom.

   b. No over excavation will be measured or paid when unsuitable conditions result from dewatering system not in conformance with Section 01578 - Control of Ground and Surface Water.

3. No additional payment will be made for performing Critical Location exploration excavation. Include cost in unit price for installed underground piping, sewer, conduit, or duct work.

4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price

1.03 DEFINITIONS

A. Pipe Foundation: Suitable and stable native soils that are exposed at trench subgrade after excavation to depth of bottom of bedding as shown on Drawings, or foundation backfill material placed and compacted in over-excavations.

B. Pipe Bedding: Portion of trench backfill that extends vertically from top of foundation up to level line at bottom of pipe, and horizontally from one trench sidewall to opposite sidewall.

C. Haunching: Material placed on either side of pipe from top of bedding up to spring line of pipe and horizontally from one trench sidewall to opposite sidewall.

D. Initial Backfill: Portion of trench backfill that extends vertically from spring line of pipe (top of haunching) up to level line 12-inches above top of pipe, and horizontally from one trench

sidewall to opposite sidewall.

E. Pipe Embedment: Portion of trench backfill that consists of bedding, haunching and initial backfill.

F. Trench Zone: Portion of trench backfill that extends vertically from top of pipe embedment up to pavement subgrade or up to final grade when not beneath pavement.

G. Unsuitable Material: Unsuitable soil materials are the following:

1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.

2. Materials that cannot be compacted to required density due to gradation, plasticity, or moisture content.

3. Materials that contain large clods, aggregates, stones greater than 4-inches in any dimension, debris, vegetation, waste or any other deleterious materials.

4. Materials that are contaminated with hydrocarbons or other chemical contaminants.

H. Suitable Material: Suitable soil materials are those meeting specification requirements. Materials mixed with lime, fly ash, or cement that can be compacted to required density and meeting requirements for suitable materials may be considered suitable materials, unless otherwise indicated.

I. Backfill: Suitable material meeting specified quality requirements placed and compacted under controlled conditions.

J. Ground Water Control Systems: Installations external to trench, such as well points, educators, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of trench excavation, and depressurization to prevent failure or heaving of excavation bottom. Refer to Section 01578 - Control of Ground Water and Surface Water.

K. Surface Water Control: Diversion and drainage of surface water runoff and rainwater away from trench excavation. Rainwater and surface water accidentally entering trench shall be controlled and removed as part of excavation drainage.

L. Excavation Drainage: Removal of surface and seepage water in trench by sump pumping and using drainage layer, as defined in ASTM D 2321, placed on foundation beneath pipe bedding or thickened bedding layer of Class I material.

M. Trench Conditions are defined about stability of trench bottom and trench walls of pipe embedment zone. Maintain trench conditions that provide for effective placement and compaction of embedment material directly on or against undisturbed soils or foundation backfill, except where structural trench support is necessary.

1. Dry Stable Trench: Stable and substantially dry trench conditions exist in pipe embedment zone as result of typically dry soils or achieved by ground water control (dewatering or depressurization) for trenches extending below ground water level.

2. Stable Trench with Seepage: Stable trench in which ground water seepage is controlled by excavation drainage.

    a. Stable Trench with Seepage in Clayey Soils: Excavation drainage is provided in lieu of or to supplement ground water control systems to control seepage and provide stable trench subgrade in predominately clayey soils prior to bedding placement.

    b. Stable Wet Trench in Sandy Soils: Excavation drainage is provided in embedment zone in combination with ground water control in predominately sandy or silty soils.

3. Unstable Trench: Unstable trench conditions exist in pipe embedment zone if ground water inflow or high-water content causes soil disturbances, such as sloughing, sliding, boiling, heaving or loss of density.

N. Sub-trench: Sub-trench is special case of benched excavation. Sub-trench excavation below trench shields or shoring installations may be used to allow placement and compaction of foundation or embedment materials directly against undisturbed soils. Depth of sub-trench depends upon trench stability and safety as determined by Contractor.

O. Trench Dam: Placement of low permeability material in pipe embedment zone or foundation to prohibit ground water flow along trench.

P. Over-excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below top of foundation as shown on Drawings and backfilled with foundation bedding.

Q. Foundation Bedding: Natural soil or manufactured aggregate of controlled gradation, and geotextile filter fabrics as required, to control drainage and material separation. Foundation bedding is placed and compacted as backfill to provide stable support for bedding. Foundation bedding materials may include concrete seal slabs.

R. Trench Safety Systems include both protective systems and shoring systems as defined in Section 02260 - Trench Safety Systems.

S. Trench Shield (Trench Box): Portable worker safety structure moved along trench as work proceeds, used as protective system and designed to withstand forces imposed on it by cave in, thereby protecting persons within trench. Trench shields may be stacked if so designed or placed in series depending on depth and length of excavation to be protected.

T. Shoring System: Structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins, or to prevent movement of ground affecting adjacent installations or improvements.

U. Special Shoring: Shoring system meeting special shoring as specified in Paragraph 1.08, Special Shoring Design Requirements, for locations identified on Drawings.

V. Vacuum Excavation: An excavation technique performed by an experienced subcontractor

in which water or air jetting is used to slough off and vacuum away soil.

W. Large Diameter Water Line (LDWL): Water line that is 24-inches in diameter or larger. X. Emergency Action Plan (EAP): The EAP document should include a discussion of procedures for timely and reliable detection, classification (level of emergency) and response procedure to a potential emergency condition associated with a large diameter water line.

Y. Subsurface Utility Exploration (SUE): Non-destructive excavation, unless otherwise approved by project manager.

1.04 REFERENCES

A. ASTM A 798 – Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications.

B. ASTM C 12 - Standard Practice for Installing Vitrified Clay Pipelines.

C. ASTM C 891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures

D. ASTM C 1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations

E. ASTM C 1675 - Standard Practice for Installation of Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers

F. ASTM C 1821 - Standard Practice for Installation of Underground Circular Precast Concrete Manhole Structures

G. ASTM D 558 - Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures.

H. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 KN-m/m^3)).

I. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.

J. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.

K. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classifications System).

L. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

M. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

N. ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

O. TxDOT Tex-101-E - Preparing Soil and Flexible Base Materials for Testing.

P. TxDOT Tex-110-E - Particle Size Analysis of Soils.

Q. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA).

1.05 SCHEDULING

A. Schedule work so that pipe embedment can be completed on same day that acceptable foundation has been achieved for each section of pipe installation, manhole, or other structures.

B. For proposed utility adjacent to or across existing LDWL:

1. Conduct a meeting between contractor, Drinking Water Operations and Utility Maintenance Branch prior to beginning excavation to coordinate the EAP in the event a water line shut down becomes necessary.

2. Notify Drinking Water Operations a minimum of 1 week prior to beginning construction activities.

3. Notify Drinking Water Operations a minimum of 48 hours prior to beginning SUE work near LDWL.

4. Unless otherwise approved by City Engineer, perform construction activities between 7 AM and 7 PM, Monday through Friday. No work permitted around a LDWL on weekends or City Holiday.

5. A City Inspector must be present during SUE or construction activities occurring within four feet or one diameter of the LDWL, whichever is greater, from an LDWL or appurtenance.

1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit planned typical method of excavation, backfill placement and compaction including:

1. Trench widths.

2. Procedures for foundation and pipe zone bedding placement, and trench backfill compaction.

3. Procedures for assuring compaction against undisturbed soil when pre-manufactured trench safety systems are proposed.

C. Submit backfill material sources and product quality information in accordance with requirements of Section 02320 - Utility Backfill Materials.

D. Submit trench excavation safety program in accordance with requirements of Section 02260 - Trench Safety System. Include designs for special shoring meeting requirements defined in Paragraph 1.08, Special Shoring Design Requirements contained herein.

E. Submit record of location of utilities as installed, referenced to survey control points. Include locations of utilities encountered or rerouted. Give stations, horizontal dimensions, elevations, inverts, and gradients.

F. Submit 11-inch by 17-inch or 12-inch by 18-inch copy of Drawing with plotted utility or obstruction location titled "Critical Location Report" to Project Manager.

G. For installation of proposed utility adjacent to or across existing LDWL, prepare and submit the following to Drinking Water Operations prior to beginning construction activities. Obtain approval from Drinking Water Operations prior to commencing relocate or utility work near LDWL.

1. Trench details, shoring system designs, installation sequences, and flowable fill mix designs.

2. Emergency Action Plan (EAP) to address contingency plans in the event of damage to or failure of LDWL. Include the following:

a. Contact personnel and agencies including primary and secondary telephone numbers.

b. Contractor’s hierarchy of responsible personnel.

c. Traffic control measures.

d. Identification of resources to be available on or near project site in event of damage or failure of LDWL.

1.07 TESTS

A. Testing and analysis of backfill materials for soil classification and compaction during construction will be performed by an independent laboratory provided by City in accordance with requirements of Section 01454 - Testing Laboratory Services and as specified in this Section.

B. Perform backfill material source qualification testing in accordance with requirements of Section 02320 - Utility Backfill Materials.

1.08 SPECIAL SHORING DESIGN REQUIREMENTS

A. Have special shoring designed or selected by Contractor's Professional Engineer to provide support for sides of excavations, including soils and hydrostatic ground water pressures as applicable, and to prevent ground movements affecting adjacent installations or improvements such as structures, pavements and utilities. Special shoring may be a premanufactured system selected by Contractor's Professional Engineer to meet project site requirements based on manufacturer's standard design.

PART 2 - PRODUCTS

2.01 EQUIPMENT

A. Perform excavation with hydraulic excavator or other equipment suitable for achieving requirements of this Section.

B. Use only hand-operated tamping equipment until minimum cover of 12-inches is obtained over pipes, conduits, and ducts. Do not use heavy compacting equipment until adequate cover is attained to prevent damage to pipes, conduits, or ducts.

C. Use trench shields or other protective systems or shoring systems which are designed and operated to achieve placement and compaction of backfill directly against undisturbed native soil.

D. Use special shoring systems where required which may consist of braced sheeting, braced soldier piles and lagging, slide rail systems, or other systems meeting requirements as specified in Paragraph 1.08, Special Shoring Design Requirements.

2.02 MATERIAL CLASSIFICATIONS

A. Embedment and Trench Zone Backfill Materials: Conform to classifications and product descriptions of Section 02320 - Utility Backfill Materials and Section 02321 – Cement Stabilized Sand.

B. Concrete Backfill: Conform to requirements for Class B concrete as specified in Section 03315 - Concrete for Utility Construction.

C. Geotextile (Filter Fabric): Conform to requirements of Section 02621 Geotextile.

D. Concrete for Trench Dams: Concrete backfill or 3 sack premixed (bag) concrete.

PART 3 - EXECUTION

3.01 STANDARD PRACTICE

A. Install flexible pipe, including "semi-rigid" pipe, to conform to standard practice described in ASTM D 2321, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.

B. Install rigid pipe to conform to standard practice described in ASTM C 12, C 1479, or C 1675as applicable, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.

3.02 PREPARATION

A. Establish traffic control to conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning lights for streets and intersections affected by Work and are considered hazardous to traffic movements.

B. Perform work to conform to applicable safety standards and regulations. Employ trench safety system as specified in Section 02260 - Trench Safety Systems.

C. Immediately notify agency or company owning any existing utility line which is damaged, broken, or disturbed. Obtain approval from Project Manager and agency for any repairs

or relocations, either temporary or permanent.

D. Remove existing pavements and structures, including sidewalks and driveways, to conform to requirements of Section 02221 - Removing Existing Pavements, Structures, Wood and Demolition Debris, as applicable.

E. Install and operate necessary dewatering and surface-water control measures to conform to Section 01578 - Control of Ground and Surface Water. Provide stable trench to allow installation in accordance with Specifications.

F. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed in writing, replace those which are damaged or destroyed in accordance with Section 01725 - Field Surveying.

3.03 CRITICAL LOCATION INVESTIGATION

A. Horizontal and vertical location of various underground lines shown on Drawings, including but not limited to water lines, gas lines, storm sewers, sanitary sewers, telecommunication lines, electric lines or power ducts, pipelines, concrete and debris, are based on best information available but are only approximate locations. Unless otherwise approved by Project Manager, at Critical Locations shown on Drawings, perform vacuum excavation to field verify horizontal and vertical locations of such lines within a zone 2 feet vertically and 4 feet horizontally of proposed work exclude water jetting at PCCP water line.

1. Verify location of existing utilities minimum of 7 working days in advance of pipe laying activities based on daily pipe laying rate or prior to beginning installation of auger pit or tunnel shaft. Use extreme caution and care when uncovering utilities designated by Critical Locate.

2. Notify Project Manager in writing immediately upon identification of obstruction. In event of failure to identify obstruction in minimum of 7 days, Contractor will not be entitled to extra cost for downtime including, but not limited to, payroll, equipment, overhead, demobilization and remobilization, until 7 days has passed from time Project Manager is notified of obstruction.

B. Notify involved utility companies of date and time that investigation excavation will occur and request that their respective utility lines be marked in field. Comply with utility or pipeline company requirements that their representative be present during excavation. Provide Project Manager with 48 hours' notice prior to field excavation or related work.

C. Survey vertical and horizontal locations of obstructions relative to project baseline and datum and plot on 12-inch by 18-inch copy of Drawings. For large diameter water lines, submit to Project Manager for approval, horizontal and vertical alignment dimensions for connections to existing lines, tied into project baseline, signed and sealed by R.P.L.S.

D. LDWL Relocate Requirements:

1. Field-locate LDWL, appurtenances and laterals connected directly to LDWL through use of non-probing method such as a vacuum truck (non-water jetting method) at no greater than 50-foot intervals. Locate upstream and downstream of proposed work or utility installation.

2. Record crown and side of LDWL adjacent to proposed work or utility installation. Record LDWL locations horizontally and vertically using same coordinate system employed on proposed utility drawings.

3. Tie horizontal and vertical coordinates into project baseline. Submit recordings performed by R.P.L.S to City a minimum of 14 days prior to mobilizing to site.

3.04 PROTECTION

A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within grading limits as designated on Drawings, and in accordance with requirements of Section 01562 - Tree and Plant Protection.

B. Protect and support above-grade and below-grade utilities which are to remain.

C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on Drawings.

D. Take measures to minimize erosion of trenches. Do not allow water to pond in trenches.

Where slides, washouts, settlements, or areas with loss of density or pavement failures or potholes occur, repair, re-compact, and pave those areas at no additional cost to City.

E. Contingency plans for proposed work or utility installation adjacent to or across a LDWL:

1. Conduct on-site emergency drill prior to commencing proposed utility installation, and at three-month intervals to assure EAP is current.

2. In the event a LDWL shut down becomes necessary, secure site and aid City personnel to access pipe and isolation valves as needed.

3.05 EXCAVATION

A. Except as otherwise specified or shown on Drawings, install underground utilities in open cut trenches with vertical sides.

B. Perform excavation work so that pipe, conduit, and ducts can be installed to depths and alignments shown on Drawings. Avoid disturbing surrounding ground and existing facilities and improvements.

C. Determine trench excavation widths using following schedule as related to pipe outside diameter (O.D.). Excavate trench so that pipe is centered in trench.

Nominal Pipe Size, Inches	Minimum Trench Width, Inches
Less than 18	O.D. + 18
18 to 30	O.D. + 24
36 to 42	O.D. + 36
Greater than 42	O.D. + 48

Do not obstruct sight distance for vehicles utilizing roadways or detours with stock-piled materials.

D. Use sufficient trench width or benches above embedment zone for installation of well point headers or manifolds and pumps where depth of trench makes it uneconomical or impractical to pump from surface elevation. Provide sufficient space between shoring cross braces to permit equipment operations and handling of forms, pipe, embedment and backfill, and other materials.

E. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify Project Manager and obtain instructions before proceeding.

F. Shoring of Trench Walls.

1. Install Special Shoring in advance of trench excavation or simultaneously with trench excavation, so that soils within full height of trench excavation walls will remain laterally always supported.

2. For all types of shoring, support trench walls in pipe embedment zone throughout installation. Provide trench wall supports sufficiently tight to prevent washing trench wall soil out from behind trench wall support.

3. Leave sheeting driven into or below pipe embedment zone in place to preclude loss of support of foundation and embedment materials, unless otherwise directed by Project Manager. Leave rangers, walers, and braces in place if required to support sheeting, which has been cut off, and trench wall in vicinity of pipe zone.

4. Employ special methods for maintaining integrity of embedment or foundation material. Before moving supports, place and compact embedment to sufficient depths to provide protection of pipe and stability of trench walls. As supports are moved, finish placing and compacting embedment.

5. If sheeting or other shoring is used below top of pipe embedment zone, do not disturb pipe foundation and embedment materials by subsequent removal. Maximum thickness of removable sheeting extending into embedment zone shall be equivalent of 1-inch-thick steel plate. As sheeting is removed, fill in voids left with grouting material.

G. Use of Trench Shields. When trench shield (trench box) is used as worker safety device, the following requirements apply:

1. Make trench excavations of sufficient width to allow shield to be lifted

or pulled freely, without damage to trench sidewalls.

2. Move trench shields so that pipe, and backfill materials, after placement and compaction, are not damaged nor disturbed, nor degree of compaction reduced. Re- compact after shield is moved if soil is disturbed.

3. When required, place, spread, and compact pipe foundation and bedding materials beneath shield. For backfill above bedding, lift shield as each layer of backfill is placed and spread. Place and compact backfill materials against undisturbed trench walls and foundation.

4. Maintain trench shield in position to allow sampling and testing to be performed in safe manner.

5. Conform to applicable Government regulations.

H. Voids under paving area outside shield caused by Contractor's work will require removal of pavement, consolidation and replacement of pavement in accordance with Contract Documents. Repair damage resulting from failure to provide adequate support.

I. Place sand or soil behind shoring or trench shield to prevent soil outside shoring from collapsing and causing voids under pavement. Immediately pack suitable material in outside voids following excavation to avoid caving of trench walls.

J. Coordinate excavation within 15 feet of pipeline with company's representative. Support pipeline with methods agreed to by pipeline company's representative. Use small, rubber- tired excavator, such as backhoe, to do exploratory excavation. Buckets that are used to dig near pipelines shall not have teeth or shall have guard installed over teeth to approximate bucket without teeth. Excavate by hand within 1 foot of Pipeline Company’s line. Do not use larger excavation equipment than normally used to dig trench in vicinity of pipeline until pipelines have been uncovered and fully exposed. Do not place large excavation and hauling equipment directly over pipelines unless approved by Pipeline Company’s representative.

K. When, during excavation to uncover pipeline company's pipelines, screwed collar or an oxy- acetylene weld is exposed, immediately notify Project Manager. Provide support for collar or welds. Discuss with Pipeline Company’s representative and determine methods of supporting collar or weld during excavation and later backfilling operations. When collar is exposed, request Pipeline Company to provide welder in a timely manner to weld ends of collar prior to backfilling of excavation.

L. Excavation and shoring requirements for proposed work or utility installation adjacent to or across a LDWL:

1. Identify LDWL area in field and barricade off from construction activities. Allow no construction related activities including, but not limited to, loading of dump trucks and material staging or storage, on top of LDWL.

2. Employ a groundwater control system when performing excavation activities within ten feet of LDWL to:

a. Effectively reduce hydrostatic pressure affecting excavations,

b. Develop substantially dry and stable subgrade for subsequent construction operations,

c. Prevent loss of fines, seepage, boils, quick condition or softening of foundation strata, and

d. Maintain stability of sides and bottom of excavations.

3. When edge of proposed trench or shoring is within a distance equal to one diameter of LDWL from outside of wall of LDWL, valve or appurtenance:

a. Maintain minimum of four (4) feet horizontal clearance and minimum of two (2) feet vertical clearance between proposed utility and LDWL.

b. Auger Construction

1) Maintain minimum of four (4) feet horizontal clearance between proposed utility and LDWL.

2) Dry auger method is required when auger hole is 12-inches and larger in diameter.

c. Open Cut Construction and Auger pits

1) Perform hand excavation when within four (4) feet of LDWL.

2) Employ hydraulic or pneumatic shoring system. Do not use vibratory or impact driven shoring or piling.

3) Expose no more than 30-feet of trench prior to backfilling.

4) A maximum of one (1) foot of vertical trench shall be un-braced at a time to maintain constant pressure on face of excavated soil.

5) Upon removal of shoring system, inject flowable fill into void space left behind by shoring system. Comply with Standard Specification 02322 - Flowable Fill.

d. When edge of utility excavation is greater than one diameter of LDWL from outside wall of LDWL, use a shielding system as required by Project Manager and propose utility standards and practices.

3.06 HANDLING EXCAVATED MATERIALS

A. Use only excavated materials, which are suitable as defined in this Section and conform to Section 02320 - Utility Backfill Materials. Place material suitable for backfilling in stockpiles at distance from trench to prevent slides or cave-ins.

B. When required, provide additional backfill material conforming to requirements of Section 02320 - Utility Backfill Materials.

C. Do not place stockpiles of excess excavated materials on streets and adjacent properties. Protect backfill material to be used on site. Maintain site conditions in accordance with Section 01504 - Temporary Facilities and Controls. Excavate trench so that pipe is centered in trench. Do not obstruct sight distance for vehicles utilizing roadways or detours with stockpiled materials.

3.07 TRENCH FOUNDATION

A. Excavate bottom of trench to uniform grade to achieve stable trench conditions and satisfactory compaction of foundation or bedding materials.

B. When wet soil is encountered on trench bottom and dewatering system is not required, over excavate an additional 6-inches with approval by Project Manager. Place non-woven geotextile fabric and then compact 12-inches of crushed stone in one lift on top of fabric. Compact crushed stone with four passes of vibratory-type compaction equipment.

C. Perform over excavation, when directed by Project Manager, in accordance with Paragraph 3.07.B above. Removal of unstable or unsuitable material may be required if approved by Project Manager;

1. Even though Contractor has not determined material to be unsuitable, or

2. If unstable trench bottom is encountered and an adequate ground water control system is installed and operating according to Section 01578 - Control of Ground and Surface Water.

D. Place trench dams in Class I foundations in line segments longer than 100 feet between manholes and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than 5 feet from manholes.

3.08 PIPE EMBEDMENT, PLACEMENT, AND COMPACTION

A. Remove loose, sloughing, caving, or otherwise unsuitable soil from bottoms and sidewalls of trenches immediately prior to placement of embedment materials.

B. Place embedment including bedding, haunching, and initial backfill as shown on Drawings.

C. For pipe installation, manually spread embedment materials around pipe to provide uniform bearing and side support when compacted. Protect flexible pipe from damage during placing of pipe zone bedding material. Perform placement and compaction directly against undisturbed soils in trench sidewalls, or against sheeting which is to remain in place.

D. Do not place trench shields or shoring within height of embedment zone unless means to maintain density of compacted embedment material are used. If moveable supports are used in embedment zones, lift supports incrementally to allow placement and compaction of material against undisturbed soil.

E. Place geotextile to prevent particle migration from in-situ soil into open-graded (Class I) embedment materials or drainage layers.

F. Do not damage coatings or wrappings of pipes during backfilling and compacting operations. When embedded coated or wrapped pipes, do not use crushed stone or other sharp, angular aggregates.

G. Place haunching material manually around pipe and compact it to provide uniform bearing and side support. If necessary, hold small-diameter or lightweight pipe in place during compaction of haunch areas and placement beside pipe with sandbags or other suitable means.

H. Place electrical conduit, if used, directly on foundation without bedding.

I. Shovel in-place and compact embedment material using pneumatic tempers in restricted areas, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas. Compact each lift before proceeding with placement of next lift. Water tamping is not allowed.

J. For water lines construction embedment, use bank run sand, concrete sand, gem sand, pea gravel, or crushed limestone as specified in Section 02320 - Utility Backfill Material. Adhere to the following subparagraph numbers 1 and 2.

1. Class I, II and III Embedment Materials:

a. Maximum 6-inches compacted lift thickness.

b. Compact to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698.

c. Moisture content to be within -3 percent to +5 percent of optimum as determined according to ASTM D 698, unless otherwise approved by Project Manager.

2. Cement Stabilized Sand (where required for special installations):

a. Maximum 6-inches compacted thickness.

b. Compact to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698.

c. Moisture content to be on dry side of optimum as determined according to ASTM D 698 but sufficient for effective hydration.

K. For Sanitary Sewers adhere to subparagraph numbers 1 and 2. For Storm Sewers provide cement stabilized sand per paragraph 2. This provision does not apply to Storm Sewers, constructed of HDPE pipe installed under pavement.

1. Class I Embedment Materials.

a. Maximum 6-inches compacted lift thickness.

b. Systematic compaction by at least two passes of vibrating equipment. Increase compaction effort as necessary to effectively embed pipe to meet deflection test criteria.

c. Moisture content as determined by Contractor for effective compaction without softening soil of trench bottom, foundation or trench walls.

2. Class II Embedment and Cement Stabilized Sand.

a. Maximum 6-inches compacted thickness.

b. Compaction by methods determined by Contractor to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698 for Class II materials and according to ASTM D 558 for cement stabilized materials.

c. Moisture content of Class II materials within 3 percent of optimum as determined according to ASTM D 698. Moisture content of cement stabilized sands on dry side of optimum as determined according to ASTM D 558 but sufficient for effective hydration.

L. For Storm Sewers constructed of any flexible pipe product and installed under pavement provide flowable fill pipe embedment as specified in Section 02322 - Flowable Fill.

M. Place trench dams in Class I embedment in line segments longer than 100 feet between manholes, and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than 5 feet from manholes.

3.09 TRENCH ZONE BACKFILL PLACEMENT AND COMPACTION

A. Place backfill for pipe or conduits and restore surface as soon as practicable. Leave only minimum length of trench open as necessary for construction.

B. For water lines, under pavement and to within one foot back of curb, use backfill materials described below:

1. For water lines 20-inches in diameter and smaller, use bank run sand or select backfill materials up to pavement base or subgrade.

2. For water lines 24-inches in diameter and larger, backfill with suitable on-site material (random backfill) up to 12-inches below pavement base or subgrade. Place minimum of 12-inches of select backfill below pavement base or subgrade.

C. For sewer pipes (Storm and Sanitary), use backfill materials described by trench limits.

For "trench zone backfill" under pavement and to within one foot back of curb, use cement stabilized sand for pipes of nominal sizes 36-inches in diameter and smaller to level 12 inches below the pavement. For sewer pipes 42-inches in diameter and larger, under pavement or natural ground, backfill from 12-inches above top of pipe to 120 inches below pavement with suitable on-site material or select backfill. Use selected backfill for rigid pavements or flexible base material for asphalt pavements for 12-inch backfill directly under pavement. For backfill materials reference Section 02320 - Utility Backfill Materials. This provision does not apply where a Storm Sewer is constructed of any flexible pipe product.

D. For Storm Sewers constructed of any flexible pipe product and installed under pavement provide flowable fill as specified in Section 02322 - Flowable Fill. For Storm Sewers constructed of any flexible pipe product and not installed under pavement provide cement stabilized sand.

E. Where damage to completed pipe installation work is likely to result from withdrawal of sheeting, leave sheeting in place. Cut off sheeting 1.5 feet or more above crown of pipe. Remove trench supports within 5 feet from ground surface.

F. Unless otherwise shown on Drawings. Use one of the following trench zones backfills under pavement and to within one foot of edge of pavement. Place trench zone backfills in lifts and compact. Fully compact each lift before placement of next lift.

1. Class I, II, or III or combination thereof:

   a. Place in maximum 12-inch-thick loose layers.

   b. Compact vibratory equipment to minimum of 95 percent of maximum dry density determined according to ASTM D 698.

   c. Moisture content within zero percent to 5 percent above optimum determined according to ASTM D 698, unless otherwise approved by Project Manager.

2. Cement-Stabilized Sand:

   a. Maximum lift thickness determined by Contractor to achieve uniform placement and required compaction, but do not exceed 12-inches.

   b. Compact by vibratory equipment to minimum of 95 percent of maximum dry density determined according to ASTM D 558.

   c. Moisture content on dry side of optimum determined according to ASTM D 558 but sufficient for cement hydration.

3. Class IVA and IVB (Clay Soils):

   a. Place in maximum 8-inch-thick loose lifts.

b. Compaction by vibratory Sheep foot roller to minimum of 95 percent of maximum dry density determined according to ASTM D 698.

c. Moisture content within zero percent to 5 percent above optimum determined according to ASTM D 698, unless approved by Project Manager.

G. Unless otherwise shown on Drawings, for trench excavations not under pavement, random backfill of suitable material may be used in trench zone. This provision does not apply to flexible pipes used for storm sewers.

1. Fat clays (CH) may be used as trench zone backfill outside paved areas at Contractor's option. When required density is not achieved, at any additional cost to City, rework, dry out, use lime stabilization or other approved methods to achieve compaction requirements, or use different suitable material.

2. Maximum 9-inch compacted lift thickness for clayey soils and maximum 12-inch lift thickness for granular soils.

3. Compact to minimum of 90 percent of maximum dry density determined according to ASTM D 698.

4. Moisture content is necessary to achieve density.

H. For electric conduits, remove from work used for construction of conduits before placing trench zone backfill.

3.10 MANHOLES, JUNCTION BOXES AND OTHER PIPELINE STRUCTURES

A. Below paved areas or were shown on Drawings, encapsulate manhole with cement stabilized sand; minimum of 2 feet below base, minimum 2 foot around walls, up to pavement subgrade or natural ground. Compact in accordance with Paragraph 3.09.F.2 of this Section.

B. In unpaved areas, use select fill for backfill. Existing material that qualifies as select material may be used, unless indicated otherwise on Drawings. Deposit backfills in uniform layers and compact each layer as specified. Maintain backfill material at no less than 2 percent below nor more than 5 percent above optimum moisture content, unless otherwise approved by Project Manager. Place fill material in uniform 8-inch maximum loose layers. Compact fill to at least 95 percent of maximum Standard Proctor Density according to ASTM D 698.

C. For LDWL projects, encapsulate manhole with cement stabilized sand; minimum of 1 foot below base, minimum of 2 feet around walls, up to within 12-inches of pavement subgrade or natural ground. For manholes over water line, extend encapsulation to bottom of trench. Compact in accordance with Paragraph 3.09 F.2 of this Section.

3.11 FIELD QUALITY CONTROL

A. Test for material source qualifications as defined in Section 02320 - Utility Backfill Materials.

B. Provide excavation and trench safety systems at locations and to depths required for testing and retesting during construction at no additional cost to City.

C. Tests will be performed on minimum of three different samples of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is noticeable change in material gradation or plasticity, or when requested by Project Manager.

D. At least three tests for moisture-density relationships will be performed initially for backfill materials in accordance with ASTM D 698, and for cement- stabilized sand in accordance with ASTM D 558. Perform additional moisture-density relationship tests once a month or whenever there is noticeable change in material gradation or plasticity.

E. In-place density tests of compacted pipe foundation, embedment and trench zone backfill soil materials will be performed according to ASTM D 1556, or ASTM D 2922 and ASTM D 3017, and at following frequencies and conditions.

1. For open cut construction projects and auger pits: Unless otherwise approved by Project Manager, successful compaction to be measured by one test per 40 linear feet measured along pipe for compacted embedment and two tests per 40 linear feet measured along pipe for compacted trench zone backfill material. Length of auger pits to be measured to arrive at 40 linear feet.
2. A minimum of three density tests for each full shift of Work.
3. Density tests will be distributed among placement areas. Placement areas are foundation, outer bedding, haunching, initial backfill and trench zone.
4. The number of tests will be increased if inspection determines that soil type or moisture content are not uniform or if compacting effort is variable and not considered sufficient to attain uniform density, as specified.
5. Density tests may be performed at various depths below fill surface by pit excavation. Material in previously placed lifts may therefore be subject to acceptance/rejection.
6. Two verification tests will be performed adjacent to in-place tests showing density less than acceptance criteria. Placement will be rejected unless both verification tests show acceptable results.
7. Recompacted placement will be retested at same frequency as first test series, including verification tests.
8. Identify elevation of test with respect to natural ground or pavement.

F. Recondition, re-compact, and retest at Contractor's expense if tests indicate Work does not meet specified compaction requirements. For hardened soil cement with nonconforming density, core and test for compressive strength at Contractor's expense.

G. Acceptability of crushed rock compaction will be determined by inspection.

3.12 DISPOSAL OF EXCESS MATERIAL

A. Dispose of excess materials in accordance with requirements of Section 01576 - Waste Material Disposal.

END OF SECTION 33 05 28

SECTION 33 11 00
WATER DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Buried pipe and fitting.

B. Valves.

C. Fire hydrants.

D. Thrust blocks and harnessing.

E. Field quality control.

F. Test.

G. System disinfection.

H. Connections to existing mains.

1.02 RELATED SECTIONS

A. Trenching, bedding, and backfilling for pipelines are specified in Section 33 05 28 - Trenching and Backfilling for Utilities.

B. Coordinate the work of this Section with the work of Section 22 11 01 - Water Distribution

1.03 MEASUREMENT AND PAYMENT

A. General: Measurement and payment for the water distribution system will be either by the lump- sum method or by the unit-price method as determined by the listing of the bid item for the water distribution system indicated in the Bid Schedule of the Bid Form.

B. Lump sum: If the Bid Schedule indicates a lump sum for the water distribution system, the lump- sum method of measurement and payment will be in accordance with Section 01 20 00 Price and Payment Procedures, Article 1.03.

C. Unit price: If the Bid Schedule indicates a unit price for the water distribution system, the unit- price method of measurement and payment will be as follows:

1. Measurement:

a. Water distribution system will be measured for payment by the linear foot of pipe, installed in place, tested and disinfected, for each type and size of pipe, along the centerline of the pipe with deductions made for manholes or other structures, measured from the inside face of each structure.

b. Utility structures will be measured separately for payment as specified in Section 33 05 16, Utility Structures.

c. Pipe fittings, valves, joints, pipe bedding, collar taps, and cutting of pipe will not be measured separately for payment, and all costs in connection therewith will be considered as included in the linear foot measurement for pipe.

d. Fire hydrants will be measured for payment by the individual unit (each), installed in place and acceptably tested.

e. Support of trench excavation, maintenance, support of existing utility facilities, grading, excavation and backfill, cast-in-place concrete, and incidental work pertaining to the installation of pipe will not be measured separately for payment but will be considered as included in the linear foot measurement for pipe.

2. Payment: The water distribution system will be paid for at the indicated Contract unit prices for the computed quantities as determined by the measurement method specified in Article 1.03.C.1.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM):

1.	ASTM A126	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
2.	ASTM A197	Specification for Cupola Malleable Iron
3.	ASTM A307	Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile
4.	ASTM D1784	Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
5.	ASTM D1785	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
6.	ASTM D2466	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
7.	ASTM D2564	Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
8.	ASTM D2855	Practice for Making Solvent-Cemented Joints, with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
9.	ASTM D3139	Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
10.	ASTM F439	Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
11.	ASTM F477	Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

B. American Water Works Association (AWWA):

1.	AWWA C500	Gate Valve, 3 through 48 inches NPS – for Water and Sewage System
2.	AWWA C503	Standard for Wet-Barrel Fire Hydrants
3.	AWWA C504	Rubber Seated Butterfly Valve
4.	AWWA C508	Swing-Check Valves for Water Works Service, 2 inches through 24 inches NPS
5.	AWWA C606	Grooved and Shouldered Type Joints
6.	ANSI/AWWA	Standard for Disinfecting Water Mains C651
7.	ANSI/AWWA	Specification for Polyvinyl Chloride (PVC) Pressure Pipe, C900 4 in. through 12 in. for Water Distribution

C. Water Utility District Standards: Note that all work shall be performed and completed in accordance with the jurisdictional water utility district's standard drawings and specifications. The Contractor shall be responsible for obtaining all such standards and for compliance with such standards as applicable.

D. Underwriters Laboratories Inc. (UL):

1.	UL 246	Hydrant for Fire-Protection Service

1.05 SUBMITTALS

A. Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.

B. Submit respective manufacturer's product data for manufactured materials and equipment, including all valves and fire hydrants.

C. Submit Shop Drawings showing piping layout and pipe, valves, hydrants, and locations of tie-ins, buttresses, and thrust blocks.

1.06 SUBMITTALS FOR CLOSEOUT

A. General: Refer to Section 01 77 00 - Closeout Procedures, and Section 01 78 23 - Operation and Maintenance Data, for submittal requirements and procedures.

B. Record Drawings: Record actual location of piping mains, valves, connections, and invert elevations for review.

1.07 SITE CONDITIONS

A. Excavations in which products will be buried shall be dry.

B. Coordinate the installation of the water supply system with the jurisdictional water utility owner.

C. The jurisdictional water utility district shall provide water services to the water meters' points of connection for station facilities and landscape irrigation systems, and modifications to existing

water mains, as indicated on the Contract Drawings. The Contractor shall be responsible for making all such arrangements.

PART 2 – PRODUCTS

2.01 BURIED PIPE AND FITTINGS

A. Requirements: Provide the types, sizes, and configurations of pipe, fittings, and miscellaneous materials and installation accessories as indicated.

B. PVC Pipe and Fittings, 3 Inches and Smaller:

1. Pipe: Polyvinyl chloride (PVC), ASTM D1785, Schedule 40 or 80, as indicated, Type I, Grade 1.

2. Fittings: ASTM D2466, socket weld, same material and schedule as pipe, or meeting requirements of ASTM F439, as applicable.

3. Joints: Socket welded with PVC solvent cement conforming to ASTM D2564 and ASTM D2855.

C. PVC Pipe and Fittings, 4 Inches and Larger:

1. Pipe: AWWA C900, Class 200, polyvinyl chloride (PVC) water pipe with bell and spigot ends and flexible ring joints.

2. Fittings: ASTM D1784, Type 1, Grade 1, polyvinyl chloride (PVC) fittings, Class 200, or meeting requirements of ASTM F439, as applicable.

3. Joints: ASTM D3139, gasketed bell joints with ASTM F477 gaskets.

2.02 VALVES

A. Gate Valves:

1. Gate Valves up to 2-1/2 Inches: 150-pound bronze body, non-rising stem, single wedge, threaded connection.

2. Gate Valve 3 Inches and Over: AWWA C500, iron body, bronze trim, non-rising stem with square nut, single wedge, mechanical joint ends with type gland and serrations designed for plastic pipe service.

B. Pressure Reducing Valves: All bronze construction, spring-loaded, single-seated, suitable for tight shutoff under dead-end conditions. Provide with renewable composition seat discs, nylon inserted diaphragm, bolted spring chamber, and threaded connection.

C. Backflow Preventer: Provide a device that is approved by the jurisdictional water utility company. As a minimum, the backflow preventer shall be a reduced pressure principal assembly with two rising- stem gate shut-off valves, two resilient seat ball-valve test cocks, two check valves replaceable resilient disks and seat with relief valve with replaceable seat. Backflow preventer shall be suitable for 175 psi operating pressure and 140 degrees F operating temperature and shall be of

bronze construction with bronze internal parts and stainless-steel springs, screwed inlet and outlet for 2-inch and smaller sizes, and cast iron, epoxy-coated construction with 150-pound flanged inlet and outlet for 3-inch and largersizes.

2.03 FIRE HYDRANTS

A. Provide fire hydrants and related appurtenances as indicated. Fire hydrants shall comply with the requirements of the jurisdictional authority and the standard drawings and specifications of the jurisdictional water utility district, as applicable.

B. Fire hydrants shall meet the requirements of AWWA C502 and UL 246, as applicable, and shall be wet barrel type, as a minimum, with a minimum of two discharge nozzles of size(s) required by the jurisdictional authority.

2.04 CONCRETE FOR THRUST BLOCKS

A. Provide Class 3000, 1-inch aggregate, concrete for all thrust blocks, as specified in Section 03 05 15 - Portland Cement Concrete, with reinforcement where indicated.

2.05 MISCELLANEOUS METAL

A. Tie Rods: Stainless steel, Type 316, threaded ANSI standard, bolt threaded on both ends. Minimum 1/2-inch diameter for 4-inch pipe, 5/8-inch minimum diameter for 6-inch and 8-inch diameter pipe, and 3/4-inch minimum diameter for 12-inch and larger.

B. Rod Couplings: Malleable iron, ASTM A197, turnbuckle design, female threaded to mate with tie rods, 5/8-inch and 3/4-inch sizes to mate with both rods and mechanical joint bolts.

C. Pipe Clamps: For sizes 4 inches and larger, provide with malleable iron rod sockets. Provide washers in lieu of rod sockets where authorized, conforming with ASTM A126, Class A, cast iron. Bolts and bolting shall conform with ASTM A307.

PART 3 - EXECUTION

3.01 MAINTAINING WATER SERVICES

A. Maintain water service and conduct operations at times selected to minimize the duration and inconvenience of service interruption.

B. At least 24 hours prior to the required cutting or abandoning of an existing water main, notify the jurisdictional water utility owner, and obtain approval of the schedule. Actual cutting or abandoning of an existing water main shall be performed by the Contractor after receiving approval from the owner of the facility.

C. Keep existing water mains parallel to new water mains in service until new water mains are ready for service.

D. Where the existing water main or service is to be cut for connection to new piping, the work shall be performed by the Contractor. Initial work operations shall include the test-pitting of all points of connection (tie-in) to ensure the true location of existing linework.

E. Water valves in service shall be operated only by personnel of the jurisdictional water utility owner.

F. Except as specified otherwise herein, construction methods shall be in accordance with the applicable provisions of the jurisdictional water utility owner's standard drawings and specifications.

3.02 INSTALLATION

A. Installation Requirements:

1. Excavate pipe trench in accordance with Section 33 05 28 - Trenching and Backfilling for Utilities. Hand trim bottom of trench to approximately 6 inches below invert of pipe.

2. Top of pipe to finished grade shall be 30 inches unless otherwise indicated or approved by the Engineer.

3. Place sand bedding material, meeting the requirements of Section 33 05 28 - Trenching and Backfilling for Utilities, at trench bottom, level in one continuous layer not exceeding 8 inches in compacted depth. Compact bedding to 95 percent relative density.

4. Backfill around sides and to 6 inches above pipe with cover fill tamped in place and compacted to 95 percent relative density.

5. Test pipe distribution system and place tracer wire on top of pipe as specified herein prior to covering pipe. Backfill trench in accordance with Section 33 05 28 - Trenching and Backfilling for Utilities.

6. Maintain optimum moisture content of bedding material to attain required compaction density.

7. Provide concrete thrust blocks for elbows, tees, valves, and appurtenances of buried piping. Thrust blocks shall be constructed as indicated and in accordance with AWWA requirements.

8. Install piping true to line and grade, supported and guided to assure alignment under all conditions.

9. Install pipes to allow for expansion and contraction without stressing pipe or joints.

10. Install unions at each connection to valves, both sides of each valve.

11. Make change in line with fittings. Do not spring joints to effect change of direction.

12. Do not field cut pipe unless necessary. Make such necessary cuts by means of equipment designed for the purpose, ensuring a smooth and square end.

13. For connection to existing pipe, provide pipe with suitable ends or adapters, after verification of size and type of existing pipe.

14. Install tie rods and pipe clamps at every joint fitting and valve.

B. Valves:

1. Install valves in accordance with the valve manufacturer's installation instructions.

2. Where valves are provided by the jurisdictional water utility owner, provide suitable access for performance of such work.

3. Where necessary, alter the typical valve manhole to suit actual conditions. Any alterations in valve manholes shall be operable from the street level. All operator nuts shall be plumb to the valve manholes.

4. Set valve on solid bearing.

5. Center and plumb valve box over valve. Set box cover flush with finished grade.

C. Fire Hydrants:

1. Provide fire hydrant installations as indicated. Installation shall conform with requirements of the jurisdictional fire department and the water utility owner's standard drawings and specifications.

2. Provide necessary appurtenances and accessories as required to complete the installation.

3. Paint hydrants in accordance with applicable requirements of Section 09 91 00, Painting.

4. Set hydrants plumb, locate pumper nozzle perpendicular to and facing roadway.

D. Thrust Blocks and Harnessing:

1. Provide for counteracting thrust caused by static and dynamic forces, including water hammer at bends, tees, reducers, valves, and dead ends by installing harnessing as indicated or required. For other methods, submit details for approval of the jurisdictional water utility owner prior to use.

2. Provide concrete thrust blocks as indicated where harnessing is not practicable.

E. Water Service Connections: Provide water service connections, where necessary, in accordance with the California Plumbing Code, the installation instructions of the service pipe and fittings manufacturer, and the utility company requirements with reduced pressure back-flow preventer and water meter with bypass valves.

F. Acceptance Requirements: After installation of pipes, ends of pipes shall be either capped or plugged. No piping shall be buried before being inspected and tested.

3.03 FIELD QUALITY CONTROL

A. Refer to Section 01 43 00 - Quality Assurance, for requirements.

B. Compaction testing of related earthwork shall be performed in accordance with applicable requirements of Section 31 00 00 - Earthwork.

C. If tests indicate work does not meet specified requirements, remove such work, replace, and retest at no additional cost to the district.

3.04 TESTS

A. Protection from Flooding: Provide positive measures to protect exposed, installed pipe and compacted pipe bedding from flooding during testing.

B. Notice of Testing:

1. Give 48 hours' notice of intention of testing to the jurisdictional water utility owner, which will furnish, install, and operate pumps, gages, meters, and individual pipe connections to test openings.
2. Designate largest sections feasible for testing and sterilizing. Testing and sterilizing operations shall be performed by the Contractor, at Contractor's expense.

C. Testing Requirements:

1. General:

a. Prior to backfilling, isolate the system by using approved valves, caps and plugs, or other acceptable methods.

b. Maintain such isolation throughout the performance of leakage and pressure testing.

c. Where valves are used for isolation, eliminate leakage through such valves if it occurs. Maintain new work isolated from existing water mains, except for test connections, until testing and sterilization have been completed.

2. Hydrostatic Tests:

a. For hydrostatic tests, provide approved caps and plugs in sections to be tested, and remove them after testing.

b. Prevent leakage in pipes and fittings at openings. Temporarily block plugged and capped ends to prevent displacement.

c. Install the water source connection for testing the isolated section. The Engineer may permit the use of a tap that will be furnished and installed by utility owner.

d. Provide labor and materials required for leakage testing, including excavation for installation and removal of pumps, gages, meters, and water source connections.

e. Where leakage exceeds the water utility company's standards, perform necessary corrective measures.

f. Remove and replace defective pipes, joints, fittings, valves, and other appurtenances. Reset such items if displaced.

g. Perform hydrostatic tests in accordance with the jurisdictional water utility district's requirements. All such tests shall be witnessed by the jurisdictional water utility district's representative. The Contractor shall be responsible for making all such arrangements.

h. Remove and replace defective pipes, joints, fittings, valves, and other appurtenances. Reset such items if displaced.

D. Testing and Flushing of Potable Water System: Test the potable water system hydrostatically in sections to a pressure of at least 150 psi for not less than 15 minutes, witnessed by the Engineer. Pressure test pipe before burial. Repair leaks and retest the system until the system is leak free. Use testing instruments calibrated by a qualified laboratory in accordance with Section 01 45 00-Quality Control. Test sequence shall be as follows:

1. Lines shall be fully flushed.

2. Lines shall be hydrostatically tested.

3. Lines shall be fully flushed.
4. Lines shall be fully disinfected.

3.05 SYSTEM DISINFECTION

A. Before final acceptance of the water supply system, each section of the new line shall be disinfected in accordance with ANSI/AWWA C651. One of the following sources of disinfectant shall be used:

1. Mixture of water and chlorine gas.

2. Direct application of chlorine.

3. Mixture of water and calcium hypochlorite; or

4. Mixture of water and calcium chloride.

B. Before disinfecting, flush the line thoroughly to remove dirt and extraneous materials. Clean each section of the line between valves independently.

C. Retain the disinfectant solution in the pipe for at least 24 hours. Following this sterilization period, the residual chlorine content at the ends of the section and at other representative points shall be not less than five parts per million. Then, the line shall be drained and thoroughly flushed with water until the residual chlorine content is similar to that obtained from the existing water distribution system.

D. Take water samples and test in accordance with ANSI/AWWA C651.

3.06 CONNECTIONS TO EXISTING MAINS

A. Following testing and sterilization, new water distribution lines shall be connected to existing mains as indicated. Each connection shall be made at a time and in a manner that will result in the least interruption of service.

B. All connections involving shut down of jurisdictional water utility's existing facilities shall be made under the immediate supervision of the jurisdictional water utility district. No member of the Contractor's forces may operate any valve controlling the flow of water in the water utility's existing system.

C. The Contractor shall provide tie-ins to the existing system at a time that is convenient to jurisdictional water utility district, which may be in the evenings and on weekends.

END OF SECTION 33 11 00

SECTION 33 31 00
SANITARY UTILITY SEWERAGE PIPING

PART 1 – GENERAL

SECTION INCLUDES

A. Buried Pipe and Fittings

B. Cleanouts

C. Sewage Ejector

D. Field Quality Control

1.01 RELATED SECTIONS

A. Section 01 33 00 - Submittal Procedures

B. Section 01 33 23 - Shop Drawings, Product Data, and Samples

C. Section 01 45 00 – Quality Control

D. Section 01 77 00 – Closeout Procedures

E. Section 01 78 23 – Operation and Maintenance Data

F. Section 01 78 39 – Project Record Documents

G. Section 22 13 01 – Sanitary Sewerage

H. Section 32 11 00 – Water Distribution Systems

I. Section 31 00 00 – Earthwork

J. Section 33 05 16 – Utility Structures

K. Section 33 05 28 – Trenching and Backfilling for Utilities

1.02 MEASUREMENT AND PAYMENT

A. General: Measurement and payment for the site sanitary sewerage system will be either by the lump-sum method or by the unit-price method as determined by the listing of the bid item for the site sanitary sewerage system indicated in the Bid Schedule of the Bid Form.

B. Lump Sum: If the Bid Schedule indicates a lump sum for the site sanitary sewerage system, the lump-sum method of measurement and payment will be in accordance with Section 01 20 00 - Price and Payment Procedures, under Article entitled “Lump-Sum Measurement”.

C. Unit Price: If the Bid Schedule indicates a unit price for the site sanitary sewerage system, the unit-price method of measurement and payment will be as follows:

1. Measurement:

   a. Site sanitary sewerage system will be measured for payment by the linear foot of pipe, installed in place and tested, for each type and size, along the centerline of the pipe, with deductions made for manholes or other structures, measured from the inside face of each structure.

   b. Utility structures will be measured separately for payment as specified in Section 33 05 16 - Utility Structures.

   c. Pipe fittings, joints, pipe bedding, cleanouts, collar taps, and cutting of pipe will not be measured separately for payment, and all costs in connection therewith will be considered as included in the linear foot measurement for pipe.

   d. Support of trench excavation, maintenance, support of existing utility facilities, excavation and backfill, concrete, and incidental work pertaining to the installation of sewer pipe will not be measured separately for payment but will be considered as included in the linear foot measurement for sewer pipe.

2. Payment: Site sanitary sewerage system will be paid for at the indicated Contract unit prices for the computed quantities as determined by the measurement method specified in Article 1.03.C.1.

1.03 REFERENCES

A. American National Standards Institute (ANSI):

   1. ANSI A21.11 Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings

B. American Society for Testing and Materials (ASTM):

   1. ASTM A74 Specification for Cast Iron Soil Pipe and Fittings

   2. ASTM C12 Practice for Installing Vitrified Clay Pipelines

   3. ASTM C14 Specification for Concrete Sewer, Storm Drain, and Culvert Pipe

   4. ASTM C76 Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

   5. ASTM C425 Specification for Compression Joints for Vitrified Clay Pipe and Fittings

   6. ASTM C443 Specification for Joints for Circular Concrete Sewer and Culvert Pipe, using Rubber Gaskets

   7. ASTM C564 Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings

   8. ASTM C700 Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated

9. ASTM D1785 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

10. ASTM C2321 Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe

11. ASTM D2466 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings, Schedule 40

12. ASTM D2564 Specification for Solvent Cements for Poly (Vinyl Chloride (PVC) plastic Pipe and Fittings

13. ASTM D2565 Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, Vent Pipe, and Fittings

14. ASTM D2729 Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

15. ASTM D2855 Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings

16. ASTM D3139 Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

17. ASTM F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

C. American Water Works Association (AWWA):

1. ANSI/ Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4-inch AWWA C900 through 12 inches for Water Distribution

D. Sanitary Utility District Standards: Note that all work shall be performed and completed in accordance with the jurisdictional sanitary utility district's standard drawings and specifications. The Contractor shall be responsible for obtaining all such standards and for compliance with such standards as applicable.

1.04 SUBMITTALS

A. Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.

B. Submit Shop Drawings showing piping layouts, sizes, types, cleanouts, and the sewage structure ejector station.

C. Submit the respective manufacturers' product data for manufactured materials and equipment.

D. Submit equipment manufacturer's printed operating and maintenance instructions in accordance with Section 01 78 23 - Operation and Maintenance Data, consisting of a detailed parts list, a recommended spare parts list, and complete operation and maintenance procedures.

E. Submit certified test reports of equipment, as applicable.

1.05 SUBMITTALS FOR CLOSEOUT

A. Refer to Section 01 77 00 - Closeout Procedures, and Section 01 78 39 - Project Record Documents, for submittal requirements and procedures.

B. Record actual location of piping mains, valves, connections, thrust restraints, and invert elevations.

1.06 SITE CONDITIONS

A. Excavations shall be dry immediately before and after products are installed. Provide surfaces and structures to, and on which sewerage products will be installed.

B. Coordinate the installation of the sanitary sewerage system with the jurisdictional sanitary district or utility owner.

PART 2 - PRODUCTS

2.01 BURIED PIPE AND FITTINGS

A. Requirements: Provide the types, sizes, and configurations of pipe, fittings, and miscellaneous materials and installation accessories as indicated and required. Pipe ends shall be bell and spigot, except plain end pipe shall be joined with mechanical clamp and gasket joint.

B. PVC Pipe and Fittings, 3 Inches and Smaller:

1. Pipe: Polyvinyl chloride (PVC), conforming with ASTM D1785, Schedule 40 or 80, as indicated, Type I, Grade 1, bell and spigot style solvent sealed jointed.

2. Fittings: ASTM D2466, Socket Weld, same material and schedule as pipe.

3. Joints: Socket welded with PVC solvent cement conforming with ASTM D2564 and ASTM D2855.

C. PVC Pipe and Fittings, 4 Inches and Larger:

1. Pipe: AWWA C900, Class 200, Poly (Vinyl Chloride) (PVC) Water Pipe with Bell and Spigot Ends and Flexible Ring Joints.

2. Fittings: ASTM D2466, Type 1, Grade 1, Poly (Vinyl Chloride) (PVC) Fittings, Class 200.

3. Joints: ASTM D3139 gasketed bell joints with ASTM F477 gaskets.

D. Cast Iron Soil Pipe:

1. Pipe: ASTM A74.

2. Joint Devices: ASTM C564 or ANSI A21.11, rubber gasket joint devices, as applicable.

E. Clay Pipe:

1. Pipe: ASTM C700, unperforated.
2. Joint Device: ASTM C425, compression joint.

F. Concrete Pipe:

1. ASTM C14, Class 3, unreinforced.
2. Joint Device: ASTM C443, rubber compression gasket joint.

G. Reinforced Concrete Pipe:

1. Pipe: ASTM C76, Class III, with steel reinforcement.
2. Joint Device: ASTM C443, rubber compression gasket joint

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H. Pipe Accessories:

1. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, with neoprene ribbed gasket for positive seal.

2. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers traps, and other configurations as indicated or required.

I. Pipe Bedding Material: Clean sand as specified in Section 33 05 28 - Trenching and Backfilling for Utilities.

2.02 CLEANOUTS

A. At grade cleanouts shall have an adjustable sleeve-type housing, a threaded brass plug with countersunk slot, and cast-iron frame and cover.

2.03 SEWAGE EJECTOR

A. Provide in accordance with applicable requirements of Section 22 14 29 - Sump Pumps.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that trench cut excavation base is ready to receive work and that excavations, dimensions, and elevations are as indicated.

3.02 PREPARATION

A. Excavations shall be free of water and extraneous material immediately before sanitary sewerage products are installed or placed. Bottoms of trenches shall have a 6-inch sand bed and shall be formed to support the bottom quadrant of the pipe and fittings. Should rock be encountered or should bedding material be unsuitable to support the products at design elevation, continue excavation to an elevation 8 inches below the design elevation and backfill with clean sand.

B. Hand trim excavations to required elevation.

C. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling and compacting operations.

D. Interior of pipe, pipe fittings, valves, drains, and cleanouts shall be cleaned of foreign substances before installation.

3.03 INSTALLATION REQUIREMENTS

A. Excavate pipe trench in accordance with Section 33 05 28 - Trenching and Backfilling for Utilities. Hand-trim bottom of trench to approximately 6 inches below invert of pipe.
B. Top of pipe to finished grade shall be 30 inches unless otherwise indicated or approved by the Engineer.

C. Place sand bedding material meeting the requirements of Section 33 05 28 - Trenching and Backfilling for Utilities, at trench bottom, level in one continuous layer not exceeding 8 inches in compacted depth. Compact bedding to 95 percent relative density.

D. Backfill around sides and to 6 inches above pipe with cover fill tamped in place and compacted to 95 percent relative density.

E. Test pipe distribution system and place tracer wire on top of pipe as specified herein prior to covering pipe. Backfill trench in accordance with Section 33 05 28 - Trenching and Backfilling for Utilities.

F. Maintain optimum moisture content of bedding material to attain required compaction density.

G. Install products where indicated. Remove and reinstall products that are disturbed after installation. Ends of products to which future connections will be made shall be either valves, or properly plugged, capped, and anchored.

H. Connections to existing facilities shall be made with fittings and short bends to suit the actual conditions. Connect products in accordance with the product manufacturer's installation instructions.

I. Pipe and fittings shall be set to line and grade before joints are made up. Angular deflections of joints shall not exceed the recommendations of the pipe and fitting manufacturer. Should the alignment require deflection of joints to be in excess of those recommended, use special bends to achieve the indicated deflection. Pipe ends and joints shall be prepared in accordance with the manufacturer's recommendations. As a minimum, pipe ends shall be sanded and cleaned, fittings shall be cleaned, and solvent shall be applied to both pipe and fittings.

J. Install pipe, fittings, and accessories in accordance with ASTM C12, ASTM D2321, and the manufacturer’s instructions. Seal joints are watertight.

K. Lay pipe to slope gradients as indicated.

L. Install bedding at sides and over top of pipe to minimum compacted thickness of 12 inches, compacted to 95 percent relative density.

3.04 INSTALLING PIPE

A. Protect pipe and fittings during handling to prevent damage.

B. Place, shape, and compact bedding material to receive barrel of pipe.

C. Start laying pipe at the lowest point; lay true to line and grade indicated.

D. Install pipe to bear on bedding material along its entire length.

E. Do not place the pipe on blocking material of any type.

F. Do not use wedges while installing the pipe.

G. Install pipe so that bells and grooves are on the upstream end.

H. Align each section of pipe with adjoining section leaving a uniform annular space between the bell and spigot to prevent sudden offsets in flow line.

I. As each section of pipe is laid, place sufficient bedding and backfill to hold it firmly in place.

J. Apply lubricant to rubber gasket (O-rings) immediately before joining pipe sections.

K. Keep interior of sewer clean as work progresses. Where small pipe sizes make cleaning difficult, keep a suitable swab and pulling line in the pipe, and pull through each joint immediately after jointing is completed.

L. Keep trenches and excavations dry and free of water during construction and until backfilling and compaction are completed.

M. When work is not in progress, securely plug ends of pipe and fittings to prevent extraneous matter from entering pipes and fittings.

N. Cut pipe ends, which project into a sewer structure, flush with the inside face of the structure and cover exposed pipe reinforcement with grout.

O. Where length of stub is not indicated, install a 4-foot length, and seal the free end with brick masonry bulkhead or an approved stopper.

P. Obtain the Engineer's approval before covering pipe.

Q. Where indicated, place additional bedding material around and over the pipe in lifts not exceeding 6 inches before compaction. Compact each lift before placement of the next lift.

R. Accomplish compaction by methods that will avoid damage to pipe and will not disturb its alignment and grade. The use of vibratory rollers is prohibited until compacted cover over pipe has reached 3 feet or half the pipe diameter; whichever is greater.

S. Connect sanitary sewerage systems to existing public sanitary sewers in accordance with requirements of the jurisdiction authority.

3.05 PIPE CLEANOUTS

A. Installation: Cleanouts shall be the same size as the pipe, with 4-inch diameter as a minimum. Cleanouts for drainage pipes shall consist of a long sweep 1/4 bend, or one or two 1/8 bends extended to the location indicated. Wall or accessible piping cleanouts shall be T-pattern, 90degree branch drainage fittings having screw plugs. Cleanouts shall be provided at the base of each riser

and shall consist of a wye pattern fitting with a screw plug.

B. Form and place cast-in-place concrete pad with provision for sanitary sewer pipe ends.

C. Establish elevations and invert for inlets and outlets.

D. Mount cleanout surface hub level in grout to elevation indicated.

3.06 FIELD QUALITY CONTROL

A. Requirements:

1. Refer to Section 01 45 00 - Quality Control, for field inspection and testing requirements.

2. Where drainage piping is located below invert slabs, conduct a ball, shuttlecock, or mandrel test to ensure that the line is free of obstructions after the placing of previous backfill material over the line and prior to the placement of the concrete invert slab.

3. Upon completion of the test and determination that the line is free of obstructions, plug, cap, or otherwise close the open end or ends of the installed piping to prevent the entrance of debris into the lines.

4. Immediately prior to final inspection of the work, remove debris from manholes, drain inlets, and floor scupper drains. In the presence of the jurisdictional sanitary utility owner's representative proves by one of the methods specified above that the piping is free of obstructions.

5. The Contractor shall be responsible for making all necessary arrangements with the jurisdictional sanitary utility owner for performing and witnessing the required tests.

6. Request inspection of exposed piping prior to placing backfill.

7. Compaction testing of related earthwork shall be performed in accordance with applicable requirements of Section 31 00 00 - Earthwork.

8. If tests indicate work does not meet requirements, remove such work, replace, and retest at no additional cost to the district.

B. Sanitary Pipeline Tests:

1. Perform air tests on all installed sanitary sewer pipes upon completion of backfill.

2. Hydrostatically test all installed sanitary sewer force mains.

3. Test all manholes for infiltration or exfiltration.

4. Test pipe sections by the exfiltration test.

5. Test sewer 24 inches or less in diameter with low pressure.

6. Sewers with a diameter greater than 24 inches may be tested by visual inspection.

C. Exfiltration Test:

1. Tightly plug end of pipe at downstream manhole.

2. Fill sewer, at either upstream manhole or standpipe, with water.

3. Allow water to stand for not less than eight hours, and until pipe has become saturated. Refill manhole or pipe to measuring mark and begin test.

4. Exfiltration will be determined as follows:

    a. If standpipe has been filled, maintain a head of water not less than 2 feet nor more than 15 feet above highest point in the line being tested.

        1) Exfiltration: that volume of water added to standpipe during a 20-hour period.

    b. If upstream manhole has been filled, measure original water elevation and, after 20 hours, final water elevation. Convert difference in elevation to gallons. Head of water shall be not less than 2 feet above highest point in the line being tested or not less than 2 feet above existing groundwater table, whichever is greater.

        1) Exfiltration: that volume of water calculated from the difference in elevations during a 20-hour period.

5. Allowable leakage:
    a. Not more than 200 gallons per 24 hours per diameter inch per mile of sewer.

    b. If leakage exceeds permissible loss, sewer section will not be accepted.

    c. Do not conduct another exfiltration test until conditions of groundwater surrounding pipe return to a condition like those existing at beginning of test period.

D. Infiltration Test:

1. Tightly plug end of pipe at upstream manhole.

2. Install a 90-degree notch weir in downstream manhole.

3. Allow water to accumulate behind weir until overflow is constant.

4. Allowable leakage:

    a. Not more than 200 gallons per 24 hours per diameter inch per mile of sewer.

    b. If measured infiltration is more than the allowable rate, sewer section will not

        be accepted.

E. Low-Pressure Air Test:

1. Clean and set sections of pipe to be tested before air test starts.

2. Plug pipe outlets with pneumatic plugs capable of resisting internal testing pressures without

requiring external bracing.

3. Immediately following pipe cleaning and wetting, slowly supply air to plugged pipe until internal air pressure reaches 4 psi. Allow at least two minutes for temperature to stabilize before proceeding, except slowly add air to maintain a 3.5 psi to 4 psi pressure. While temperature is stabilizing, spray plugs, pipes, and hoses with soap solution and eliminate air leaks.
4. After temperature has stabilized, measure time required for pressure to drop from 3.5 psi to 2.5 psi. If measured time exceeds allowable time, pipe will not be accepted.
5. Time, in seconds, for pressure to drop from 3.5 to 2.5 psi shall be not less than the following: time for intermediate lengths shall be interpolated:

Length of Pipe Diameter in Inches

Pipe (Ft)	8	10	12	15	18	21	24
25	18	28	40	62	89	121	158
50	35	55	79	126	178	243	317
75	53	83	119	186	267	364	475
100	70	110	158	248	356	485	634
125	83	38	198	309	444	595	680
150	100	165	238	375	510	595	680
175	123	193	277	425	510	595	680
200	141	120	317	425	510	595	680
225	158	248	340	425	510	595	680
250	176	275	340	425	510	595	680

F. Visual Test Method: Slowly pull a television camera through sewer and inspect for visual leaks and cracks in pipe. Repair leaks, then re-inspect pipe.

G. Joint Pressure Testing:

1. Insert sealing packer with joint testing capability, into sewer line.
2. Place sealing packer around joint and pressure test joint. If a drop in air pressure occurs, reseal the joint.
3. Repeat procedure for each joint.

H. Criteria for Acceptance: The section of sewer being tested will not be accepted if test results exceed allowable leakage or take less time than minimum holding time. If pipe proves to be unacceptable, immediately repair defective materials and installation. The Contractor will not be permitted to change to another test if original test method reveals system has failed.

I. Obstruction Tests:

1. Perform field tests to verify that installed sanitary systems are free from obstructions.
2. Remove obstructions by excavating at the apparent obstruction and repairing or replacing the defective pipe.

END OF SECTION 33 31 00

SECTION 33 41 00
STORM SEWAGE SYSTEM

PART 1 – GENERAL

1.01 DESCRIPTION

A. This Section specifies the requirements for providing storm sewers and appurtenant structures.

1.02 QUALITY ASSURANCE

A. Reference Standards Applicable to this Section

1. AASHTO: American Association of State Highway and Transportation Officials

   a. M 36: Specification for Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrains.

   b. M 190: Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.

   c. M 252: Specification for Corrugated Polyethylene Drainage Tubing.

   d. M 294: Specification for Corrugated Polyethylene Pipe 12 inch to 36-inch diameter.

2. ASTM: American Society for Testing and Materials

   a. A 48: Specification for Gray Iron Castings.

   b. A 74: Specification for Cast Iron Soil Pipe and Fittings.

   c. C 40: Test Method for Organic Impurities in Fine Aggregate for Concrete.

   d. C 76: Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.

   e. C 150: Specification for Portland Cement.

   f. C 443: Joints for Circular Concrete Sewer and Culvert Pipe Using Rubber Gaskets.

   g. C 881: Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

   h. D 618: Conditioning Plastics and Electrical Insulating Materials for Testing.

   i. D 1248: Polyethylene Plastics Molding and Extrusion Material.

   j. D 1693: Environmental Stress Cracking of Ethylene Plastics.

k. D 1785: Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

l. D 2239: Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.

m. D 2412: Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

o. D 2447: Specifications for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.

p. D 2466: Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

q. D 2467: Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

r. D 2564: Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

s. D 2665: Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.

t. D 2729: Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

u. D 2855: Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

v. D 3035: Specifications for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.

w. D 3212: Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

x. D 3261: Specification for Butt Heat Fusion of Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

y. D 3350: Specification for Polyethylene Plastics Pipe and Fittings Material.

z. F 402: Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings.

aa. F405: Specification for Corrugated Polyethylene (PE) Tubing and Fittings.

bb. F 412: Standard Terminology Relating to Plastic Piping Systems.

cc. F 477: Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

dd. F 656: Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Pipes and Fittings.

ee. F 714: Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

ff. F 913: Standard Specification for Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

gg. F 667: Specification for Large Diameter Corrugated Polyethylene Tubing and Fittings.

3. Federal Specification

a. SS-S-210A and Latest Amendments: Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.

4. Houston

a. Standard Construction Specifications for Wastewater Collection Systems, Water Lines, Storm Drainage and Street Paving, September 1996 or latest revision.

1.03 SUBMITTALS

A. In accordance with Section 013300 – Submittal Procedures of these Specifications, the following shall be submitted:

1. Certificates

a. Manufacturer's certificates and load tickets stating that materials meet specified requirements.

2. Shop Drawings

a. Shop Drawings and details of all storm sewers and drains, including relationship to other systems and true position and details of all interfaces, connections, inlets, clean- outs, manholes, alignment and grade, changes of direction, offsets, bedding and protection, materials, manufacturer's installation and connection instructions and recommendations, and all other pertinent data.

PART 2 - PRODUCTS

2.01 GENERAL

A. Products for use within right-of-way shall meet the applicable requirements.

2.02 PIPES AND FITTINGS

A. Reinforced Concrete Pipe (RCP)

1. ASTM C 76, bell-and-spigot, Class III, Wall B.

B. Corrugated Galvanized Metal Pipe (CGMP)

1. AASHTO M 36, coated and paved in accordance with AASHTO M 190, Type C coating

for pipe and Type A coating for coupling bands.

C. PVC Pipe in accordance with the following:

1. ASTM D 1785.
2. ASTM D 2241.
3. ASTM D 2466.
4. ASTM D 2467.

D. PE Pipe

1. ASTM D 2447.
2. ASTM D 3035.
3. ASTM D 3350 Type PE 3408.
4. ASTM F 714 Type PE 3408.

2.03 JOINTS

A. Gaskets for RCP in accordance with the following:

1. Federal Specification SS-S-210A.
2. ASTM C 443.

B. All joints in PVC plastic pipe shall be solvent cemented in accordance with the following:

1. ASTM D 2564.
2. ASTM D 2672.
3. ASTM D 2855.
4. ASTM F 402.
5. ASTM F 656.

C. All joints in PE plastic pipe shall be fusion butt-welded in accordance with ASTM 3261.

2.04 DRAINAGE STRUCTURES

A. Manhole

Type as indicated on the Drawings and conforming to applicable Standards for Houston or HCFCD Right-of-Way, or KISD Property. Frame and Cover ASTM A 48 Class 35 B.

B. Inlet

Type as indicated on the Drawings and conforming to applicable Standards in Houston or HCFCD Right-of-Way, or KISD Property. Frame and Grate ASTM A 48 Class 35 B.

C. Reinforcing Steel

As specified in Section 032100 - Concrete Reinforcement of these Specifications.

D. Cast-in-Place Concrete (Class 3000)

As specified in Section 321373.19 - Cast-in-Place Concrete of these Specifications.

E. Mortar (Type M)

2.05 CEMENT-STABILIZED SAND BACKFILL

A. Aggregate

Use clean sand; deleterious materials in the sand shall not exceed the following limitations, by weight:

Material removed by denotation	5.0 percent
Clay lumps	0.5 percent
Other deleterious substances such as coal, shale, coated grains of soft flaky particles.	2.0 percent

Graduation Requirements:

Retained on 3/8-in. sieve	0 percent
Retained on 1/4-in. sieve	0 - 5 percent
Retained on 20-mesh sieve	15 - 50 percent
Retained on 100-mesh sieve	80 - 100 percent

Color test per ASTM C 40, color not darker than standard color.

B. Cement

ASTM C 150, Type I or II.

C. Water

Potable, from municipal supplies approved by the State or City Health Department.

D. Mixture

Use at least 1-1/2 sacks of cement per cubic yard of mixture. Use amount of water required to provide mix suitable for mechanical hand tamping and mix in approved mixer. Stamp load tickets at plant with time of loading. Material not in place within 1-1/2 hours after loading or that has obtained an initial set will be rejected and shall be removed from the Site and replaced with new acceptable mixtures at no additional cost to COM.

2.06 TIMBER POSTS

A. Southern Pine or Douglas Fir, pressure-treated in accordance with American Wood Preservers' Association (AWPA) Standards.

PART 3 - EXECUTION

3.01 GENERAL

A. All storm sewer work performed within Houston right-of-way shall meet the applicable requirements.

3.02 EXCAVATION

A. All excavation shall be in accordance with Section 017330 - Trench Safety Systems of these Specifications.

B. Perform excavation for storm sewer and storm sewer drainage structures to line and grade required as shown on the Drawings and as specified herein.

C. If the excavation exceeds the permissible dimensions, extend the encasement or install pipe of higher strength, as directed.

D. Prevent surface or ground water from flowing into excavation. Install, operate, and maintain dewatering system to convey water away from excavation. Notify the Engineer in writing of delays to the Work caused by water intrusion.

3.03 PIPE ENCASEMENT

A. Place cement-stabilized sand bedding before laying pipe. Bedding shall be compacted and shaped to fully support the pipe.

B. After the pipe is laid, place cement-stabilized sand beside and above the pipe in 4 in. lifts to the limits shown on the construction drawings. Compact individual lifts with a hand-operated, motorized tamper; exercise care to avoid damaging the pipe.

3.04 LAYING PIPE

A. Install and joint pipe in accordance with the pipe manufacturer's instructions and as specified herein.

B. Provide a minimum of 6 in. clearance between storm sewer and sanitary sewer.

C. Seal open end of pipe with plug when pipe laying operation is temporarily halted. Plug shall remain in place until operation restarts.

3.05 BACKFILL

A. On completion of construction, backfill the excavation as specified in Section 312300 –Grading, Excavation and Fill of these Specifications and in accordance with details on the construction drawings. Backfill only when the written approval of the Engineer is obtained to do so.

3.06 CONSTRUCTION OF MANHOLES AND INLETS

A. General

1. Construct manholes and inlets as soon as practical after sewer lines into or through the manhole or inlet locations are completed.

2. Construct manholes and inlets at locations and of the type indicated. All manholes within 9 feet of existing water lines shall be watertight.

B. Manholes

1. Provide base of the shape and size required with a minimum thickness of 12 inches.
2. Place axis of manholes directly over the centerlines of the lines, unless otherwise indicated.

3. Shall be constructed of either precast or cast-in-place concrete.

C. Inlets

1. Shall be constructed of either precast or cast-in-place concrete.

3.07 CLEANUP

A. Remove temporary structures, rubbish, waste materials, and excess excavated materials from the Site and dispose of legally.

END OF SECTION 33 41 00