Statement of Work
Large Enclosure, High Power X-ray
Computed Tomography (CT) System

1.0 SCOPE

This Statement of Work (SOW) defines the requirements for a turnkey, state-of-the-art, dual-tube X-ray Computed Tomography (CT) system. The contractor shall provide all hardware, software, installation, training, and documentation required to deliver a fully functional system compliant with the specifications herein.

2.0 GENERAL REQUIREMENTS

2.1 Radiation Safety Compliance: The CT system shall be a fully shielded, interlocked cabinet-style unit compliant with 21 CFR 1020.40 and all applicable industry regulations.

2.2 Scan Envelope: The system shall be capable of scanning parts with a minimum dimension of 60 inches in diameter and 84 inches in height.

2.3 Manipulator & Turntable: The system shall be equipped with a manipulator featuring a minimum of six (6) independent axes of control. It shall include a turntable translation feature for increased scanning volume capability, alongside a high-precision micro-positioning system for the turntable.

2.4 Dual-Detector Future Expansion: The CT system design must accommodate the option of installing a second detector at a later date, enabling transition to a dual-detector configuration. The independent axes of control shall permit either tube to be operated with either detector.

2.5 Physical Transport Dimensions: The overall maximum dimensions of the system during transport shall permit the unit to fit through a 10-foot by 10-foot roll-up door into the host facility.

3.0 DETAILED SYSTEM REQUIREMENTS

3.1 Hardware Specifications

3.1.1 Microfocus (225kV) X-ray Tube: The contractor shall provide one (1) microfocus X-ray (CT capable) tube rated for at least 225kV, as specified in the technical requirements.

3.1.2 Meso-focus (450kV) X-ray Tube: The contractor shall provide one (1) high-resolution Meso-focus X-ray tube rated for at least 450kV.

3.1.3 Digital Panel Detector: The contractor shall provide one (1) CT-grade digital detector array flat panel x-ray detector rated for energies up to 450kV, featuring a 150µm pixel pitch, 16-bit resolution, and multiple gain and frame rate settings.

3.1.4 Uninterruptible Power Supply (UPS). The contractor shall provide an uninterruptible power supply for the X-ray tubes and their generators, including any software needed to direct a proper system shutdown in the event of a power loss. If providing a physical UPS is not feasible, the contractor shall instead deliver detailed technical documentation specifying the power requirements needed for the Government to procure a compatible UPS.

3.1.5 Workstations: The contractor shall provide one (1) acquisition workstation and two (2) separate reconstruction workstations. All computers shall feature easily hot-swappable hard drives, RAID backup, and optimized CPU, GPU, and RAM configurations.

3.1.6 Monitors: The reconstruction workstations shall be equipped with at least one (1) radiography interpretation grade monitor each.

3.2 Software Requirements

3.2.1 Acquisition & Reconstruction Software: The software shall support 2D X-ray data acquisition (native resolution, sub-pixel, region of interest, and stitched data with required panel corrections) and 3D CT acquisition modes (continuous, step, sub-pixel, region of interest, stitched, spiral/helical, offset, and partial-rotation CT scans).

3.2.2 Data Analysis Software: The reconstruction workstations shall include dongle licenses for post-processing software capable of performing automated dimensional measurements, surface extraction, data correction algorithms, porosity/inclusion analysis, and CAD comparison. All software must be fully compatible and equivalent with VGStudio MAX.

4.0 TRAINING & MAINTENANCE

4.1 Comprehensive Maintenance. The contractor shall provide a comprehensive system maintenance contract for a base period of one (1) year, commencing upon final system acceptance. This comprehensive maintenance shall include all software licenses, software updates, and preventative maintenance visits. The solicitation will also include an option CLIN for a second year of comprehensive maintenance coverage.

4.2 On-Site Training. The contractor shall provide three-to-four (3-4) days of on-site training for up to four (4) Navy personnel, covering hardware operation, software use (excluding VGSTUDIO MAX), and all end-user maintenance procedures.

4.3 Theory Course. The contractor shall provide three (3) seats to a 40-hour ASNT CP-105/NAS410 compliant course on Digital Detector Array and Computed Tomography theory.

5.0 DELIVERY, INSTALLATION, AND ACCEPTANCE

5.1 Shipping & Installation: The contractor is responsible for shipping and complete installation of the system at the Naval Air Warfare Center Aircraft Division, Building 2933, Patuxent River, MD 20670.

5.2 Completion Timeline (Physical Items & On-site Training): Complete delivery, installation, validation of physical and software components, and on-site training shall occur no later than 12 months after contract award.

5.3 Completion Timeline (Theory Course): The 40-hour off-site theory training course shall be completed no later than 18 months after contract award.

5.4 Final Acceptance: Final Government acceptance will occur only after the technical SME verifies the system is fully functional and a satisfactory X-ray radiation safety survey is executed.

5.5 Documentation. All required documentation shall be provided either physically (printed, legible) or as verified, functioning PDF files prior to final acceptance.

6.0 SECURITY REQUIREMENTS

6.1 Installation Security Compliance: While performing services on government property, the contractor and all contractor personnel shall comply with all local installation security policies, regulations, and procedures.

6.2 Access Badges and Passes: The contractor shall be responsible for coordinating with the Government and ensuring the timely provision of all security badges, vehicle passes, and base access credentials required for Contractor personnel to access designated workspaces and materials.

6.3 Law Enforcement and Security Directives: Contractor personnel shall strictly comply with all lawful directions and instructions provided by Military Police, Base Security, or other authorized installation security personnel.

6.4 Base Traffic Regulations: Contractor personnel operating personal or company vehicles on the military installation shall adhere to all local installation traffic laws, speed limits, and parking regulations.

7.0 DETAILED SYSTEM SPECIFICATIONS.

7.1 Microfocus (225kV) X-ray Tube

The contractor shall provide the following as part of the Microfocus X-ray Tube assembly:

7.1.1 One (1) Microfocus X-ray (CT capable) tube capable of operating at a minimum of 225kV. The tube shall be capable of achieving a JIMA Resolution of 4μm and have a Focal Spot Size (in μm) to Power (in watts) relationship of 1-to-1 or lower.

7.1.2 One (1) complete set of all technical, operational, safety, and end-user maintenance documentation related to the tube.

7.1.3 One (1) set of collimators to constrict the beam.

7.1.4 One (1) set of copper filters for use at the tube head, including a secure holding mechanism.

7.1.5 One (1) set of spare consumables for the tube (e.g., targets, filaments, O-rings).

7.1.6 One (1) maintenance kit for routine end-user maintenance (e.g., grease, polishing paste, required tools).

7.1.7 One (1) set of common spare parts (e.g., grid caps, bulbs, cables, screws, tube window).

7.1.8 One (1) high-voltage generator and one (1) high-voltage cable of appropriate length.

7.1.9 One (1) maintenance kit for the high-voltage generator, to include common parts such as silicone grease and a spare high-voltage receptacle.

7.1.10 One (1) OEM-specified vacuum pump and one (1) corresponding maintenance kit.

7.1.11 One (1) OEM-specified cooling system and one (1) corresponding maintenance kit.

7.1.12 All software and related documentation required to correctly and safely operate the tube, including warm-up cycles and conditioning.

7.1.13 Performance and Reliability

7.1.13.1 Prior to acceptance, the contractor shall test the X-ray tube to demonstrate its ability to

operate at maximum kV for no less than six (6) continuous hours without faults that would cause a CT scan failure (e.g., arc strikes, data degradation).

7.1.13.2 The X-ray tube shall not require more than three (3) preventative maintenance visits by a certified technician per 12-month interval under normal operating conditions.

7.2 450kV High Resolution X-ray Tube

The contractor shall provide the following as part of the 450kV High Resolution X-ray Tube assembly:

7.2.1 One (1) 450kV high-resolution, CT-capable X-ray tube.
7.2.2 One (1) 450kV high-voltage generator and one (1) maintenance kit for the generator, to include common parts such as silicone grease and a spare high-voltage receptacle.
7.2.3 One (1) laser centering device, if available and compatible, including any required mounting hardware.
7.2.4 One (1) 4-leaf, independently controlled source/tube-side collimator.
7.2.5 One (1) OEM-specified cooling system and one (1) corresponding maintenance kit.
7.2.6 One (1) set of copper filters and a means of securing them to the tube head.
7.2.7 One (1) set of common spare parts for the tube (e.g., bulbs, cables, screws).
7.2.8 One (1) set of spare consumables for the tube (e.g., targets, filaments, O-rings), if applicable.
7.2.9 One (1) OEM-specified vacuum pump and one (1) corresponding maintenance kit, if required by the tube's design.
7.2.10 All software and related documentation required to correctly and safely operate the tube, including warm-up cycles and conditioning.
7.2.11 One (1) complete set of all technical, operational, safety, and end-user maintenance documentation related to the tube.
7.2.12 Performance and Reliability

7.2.12.1 Prior to acceptance, the contractor shall test the X-ray tube to demonstrate its ability to operate at maximum kV for no less than six (6) continuous hours without faults that would cause a CT scan failure (e.g., arc strikes, data degradation).

7.2.12.2 The X-ray tube shall not require more than three (3) preventative maintenance visits by a certified technician per 12-month interval under normal operating conditions.

7.3 Flat Panel Digital Detector Array (DDA)

The contractor shall provide the following as part of the DDA assembly:

7.3.1 One (1) Varex XRD 4343N Digital Detector Array, or equivalent, with the following minimum characteristics:

a. Size: 17" by 17" (nominal)
b. Pixel Pitch: 150µm
c. Grade: CT/Premium Grade
d. Scintillator: Appropriate for 450kV operation
e. Shielding: Includes any additional shielding required for safe 450kV operation
7.3.2 One (1) 4-leaf, independently controlled active collimator located at the detector face.
7.3.3 One (1) complete set of replacement data and power cables for the detector.
7.3.4 All software and documentation required to operate and maintain the detector.
7.3.5 One (1) complete set of all technical, operational, safety (including ASTM E2597 compliance data), and end-user maintenance documentation for the detector.
7.3.6 Verification

7.3.6.1 Prior to acceptance, the contractor shall provide verification that the supplied DDA is of CT/Premium Grade and shall demonstrate its compliance with these specifications to the Government's technical representative.

7.4 X-ray Enclosure

The contractor shall provide one (1) X-ray enclosure with the following features and components:

7.4.1 Core Specifications

a. The enclosure shall be compliant with 21 CFR 1020.40.
b. The enclosure shall provide safe shielding for X-ray generation up to and including 450kV at 450W.
7.4.2 Motion Control and Precision

a. The enclosure shall contain a motion control system with the following minimum axes: Table (Left/Right, Forward/Back, and Rotation) and Detector (Left/Right, Up/Down), plus independent vertical controls (Up/Down) for each X-ray tube.
b. The table's rotational axis shall have a precision of 0.001 degrees or better.
c. All motion axes and the micro-positioning system shall have a positional repeatability of 0.1mm or better.
d. The system shall include one (1) micro-positioning control system for the main table and one (1) kit of spare parts for its maintenance.
7.4.3 Safety Features

a. The enclosure shall include a coordinated safety alarm system with both an audible and a visual pre-warn alarm prior to X-ray generation, followed by a clear "X-ray ON" visual indicator.
b. The system shall provide a set of interior cameras for monitoring the enclosure when the access door is closed.

7.4.4 Future Expansion (Dual Detector)

a. The enclosure shall be designed to allow for the future installation of a second detector, creating a dual-tube, dual-detector system. This capability shall include provisions for mounting hardware, motion controls, and software integration.
b. If the permanent dual-detector installation described in 7.4.4.a is not feasible, the enclosure shall be designed to allow for the "hot-swapping" of detectors in a manner that is reasonable for the end-user (considering time, tools, and effort).

7.4.5 Maintenance and Spares

a. One (1) set of replacement soft-stop sensors and other common motion control sensors (e.g., IS5035, IS5036).
b. One (1) set of replacement batteries for any sensors or modules in the electrical panel that require them.
c. One (1) full set of replacement bulbs/LEDs for all warning and X-ray status lights.
d. One (1) maintenance kit for the interior monitoring cameras, if applicable.

7.4.6 Documentation

a. One (1) complete set of all technical, operational, safety, and end-user maintenance documentation for the enclosure and all related systems.

7.5 Data Acquisition Computer and Software

The contractor shall provide one (1) Data Acquisition Workstation and associated software with the following specifications:

7.5.1 Acquisition Computer Hardware

a. The computer shall be a Windows 11 workstation that meets or exceeds the recommended (not minimum) hardware requirements for all proposed acquisition software.
b. The workstation shall include a minimum of two (2) color monitors, each with at least 4MP resolution.
c. The workstation shall include a keyboard, mouse, and a tethered joystick/pendant for manipulating the X-ray enclosure's motion controls.
d. The computer's hard drives shall be designed to be easily swappable and replaceable by the end-user.
e. The computer shall include at least two (2) USB 2.0 and at least two (2) USB 3.0 ports for peripherals and external drives.

7.5.2 Data Transfer and Performance

a. The computer shall be capable of transferring data to the Reconstruction Computers at a sustained, real-world rate of no less than 300 MB/s (500 MB/s desired).
b. The computer shall be capable of writing data directly from the detector at a rate sufficient to keep up with the detector's highest frame rate without data loss or buffer overflow.

7.5.3 Acquisition Software Capabilities

a. The software shall be capable of acquiring 2D digital detector array data, including sub-pixel and stitched images.
b. The software shall be capable of acquiring 3D Computed Tomography data using, at a minimum, the following modes and relevant combinations: continuous, step, sub-pixel, stitched, spiral/helical, ring-reduction, offset, and partial-rotation scans.
c. The software shall provide tools to assist the operator in performing and calculating all relevant ASTM standard checks (e.g., E2002, E2903, E2737, E2698, E2597).
d. The software shall be capable of performing all required detector corrections, including bad pixel maps, bad pixel corrections, offset/dark field, and gain corrections.
e. The software shall provide correct and valid on-screen image analysis tools, including line profile, distance measurement, grid overlays, centering tools, ROI analysis (SNR, CNR), and histogram manipulation (window/level, invert, false color).

7.5.4 System Control and Logging

a. The software shall provide functions to properly warm up and condition the X-ray tubes and display their operational status.
b. The software shall save operational logs for all major components (X-ray tubes, detector, motion controls) to assist in troubleshooting.
c. The software shall be DICONDE compliant, capable of saving files in open-source formats and correctly associating all required metadata tags.
d. The software shall be capable of creating and saving technique sheets with all acquisition parameters.

7.5.5 Ancillary Software and Documentation

a. The computer shall be delivered with licensed installations of necessary Microsoft Office programs (e.g., Word, Excel) and other common programs (e.g., Notepad++, Adobe Acrobat) required to open, modify, and read files created by the CT system.
b. The contractor shall deliver one (1) complete set of all technical, operational, and safety documentation for all acquisition hardware and software.

7.6 Data Reconstruction Computers and Software

The contractor shall provide two (2) complete Data Reconstruction Workstations and associated software with the following specifications:

7.6.1 Reconstruction Computer Hardware

a. The computers shall be Windows 11 workstations that meet or exceed the recommended (not minimum) hardware requirements for all proposed reconstruction and post-processing software.
b. Each workstation shall include a minimum of one (1) color monitor that meets the requirements of ASTM E2698, is DICOM Part 14 compliant, and utilizes LED backlighting.
c. Each workstation shall include a keyboard and mouse.
d. The computers' hard drives shall be designed to be easily swappable and replaceable by the

end-user.
e. The computers shall include sufficient USB 2.0 and USB 3.0 ports for peripherals and external drives.

7.6.2 Data Transfer and Performance

a. The computers shall be capable of receiving data from the Data Acquisition Computer at a sustained, real-world rate of no less than 300 MB/s (500 MB/s desired).
b. The computers shall include a second data transfer port to allow for data archival to an external server or drive at a sustained, real-world rate of no less than 300 MB/s.

7.6.3 Reconstruction and Review Software Capabilities

a. The software shall be capable of receiving, reviewing, reconstructing, and post-processing all 2D and 3D X-ray data generated by the acquisition system.
b. The software shall correctly apply all captured detector corrections (e.g., bad pixel maps, offset/dark field, gain) during data review and reconstruction.
c. The software shall provide tools to assist the operator in performing and calculating all relevant ASTM standard checks (e.g., E2002, E1695).
d. The software shall provide correct and valid tools for performing measurements, using either end-user or geometric calibration data.
e. The software shall be DICONDE compliant, capable of saving files in open-source formats and correctly associating all required metadata tags.

7.6.4 Data Integrity and Interoperability

a. The software shall be capable of saving all review, reconstruction, and post-processing parameters used for a given data set.
b. All reconstructed data files shall be capable of being opened correctly and in a data-valid manner by third-party post-processing software.
c. If the contractor does not provide its own proprietary reconstruction software, the CT data files shall be deliverable in a format that can be correctly reconstructed by compatible third-party software for all scan types.

7.6.5 Ancillary Software and Documentation

a. The computers shall be delivered with licensed installations of necessary Microsoft Office programs (e.g., Word, Excel) and other common programs (e.g., Notepad++, Adobe Acrobat, VLC media player) required to open, modify, and read files related to the CT system.
b. The contractor shall deliver two (2) complete sets of all technical manuals and documentation for all reconstruction software packages.

7.7 CT Data Post-Processing Software

The contractor shall provide post-processing and analysis software that meets the minimum capabilities outlined below. The requirements can be met by providing one of the two following Volume Graphics VGSTUDIO MAX software packages:

7.7.1 Option A: Individual Modules

The contractor shall provide licenses for the following VGSTUDIO MAX modules:
a. Two (2) CAD Import Module Licenses
b. Two (2) Coordinate Measurement Module Licenses
c. Two (2) Fiber Composite Material Analysis Module Licenses
d. Two (2) Nominal/Actual Comparison Module Licenses
e. Two (2) Porosity/Inclusion Analysis Module Licenses
f. Two (2) Reverse Engineering Module Licenses
g. Two (2) Wall Thickness Analysis Module Licenses
h. One (1) Deep Segmentation Module License
i. One (1) Digital Volume Correlation Module License
j. One (1) Volume Meshing Module License
k. Two (2) CT Reconstruction Module Licenses (*Only required if the vendor does not provide their own proprietary CT reconstruction software*).

7.7.2 Option B: Bundled Packages

Alternatively, the contractor shall provide the following bundled VGSTUDIO MAX packages:
a. Two (2) VGSTUDIO MAX Dimensions Licenses
b. Two (2) VGSTUDIO MAX Analyze Licenses

7.7.3 Equivalency Clause

If the contractor does not provide one of the Volume Graphics software packages listed in 7.7.1 or 7.7.2, the proposed alternative software shall be proven to be both fully compatible with the system and functionally equivalent in capability to the specified VGSTUDIO MAX packages.

7.7.4 License Type

All provided post-processing software licenses shall be dongle-based to allow for transfer to upgraded computer hardware in the future. Node-locked or computer-bound licenses are not an acceptable substitute.

7.8 Support Items and Warranties

7.8.1 The contractor shall provide a set of any available tools to assist in system calibration, which may include but are not limited to: geometry tools, a focal spot measuring tool (compliant with ASTM E2903), alignment tools, a CT density phantom, and a JIMA resolution test chart.

7.8.2 The contractor shall provide industry-standard warranties for a minimum of one (1) year from the date of system acceptance for all major system components, including but not limited to: both X-ray tubes, the DDA detector, high-voltage generators, and radiography review-grade monitors.