Functional Specifications for a Selective Laser Sintering Three-Dimensional Additive Manufacturing Machine

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Introduction:

The Laboratory for Autonomous Systems Research (LASR) Facility, Code 1700, Naval Research Laboratory (NRL), Washington, DC, requires the procurement and installation of a Selective Laser Sintering (SLS) 3D printer as outlined below. This document specifies the minimum technical and performance requirements for the printer to be supplied and installed by the vendor awarded the contract.

Scope:

This document outlines the minimum technical specifications, operational performance standards, and installation requirements for a Selective Laser Sintering (SLS) 3D Printer. The printer will be utilized for fabricating parts designed in a 3D computer-aided design (CAD) and engineering (CAE) software and converted into STL files, which are subsequently sliced into layers and printed using various material options.

Installation Site:

The SLS printer will be installed in the LASR Facility, B271 Naval Research Laboratory, located in Washington, D.C., Zip Code 20375.

Installation Location:

The SLS printer will be installed in NRL B271, Room 131 of the LASR Facility.

1.0 System Specifications

1.01 Laser Specifications:

Laser Type: CO2 (Carbon Dioxide) Laser

Laser Power: minimum of 70 W

Wavelength: 10.6 µm (standard for CO2 lasers)

1.02 Build/Platform Size:

The system must provide a minimum build platform size of **340 mm width x 340 mm depth x 620 mm height**.

1.03 Part Resolution:

The SLS 3D printer must meet the following part resolution accuracy requirements for each axis of operation (X, Y, and Z).

Axis / Feature	Nominal Resolution (mm)	Allowable Deviation / Tolerance (mm)
X / Y Plane	0.05 – 0.08 mm	±0.020 mm
Z Plane	0.06 – 0.10 mm	±0.020 mm
Minimum Wall Thickness	0.6 – 0.8 mm	±0.20 mm
Minimum Hole Diameter	0.8 – 1.0 mm	±0.20 mm

1.03 Dimensional accuracy

The SLS 3D printer must meet the following dimensional accuracy requirements for each axis of operation (X, Y, and Z).

Axis	Accuracy (mm)	Allowable Deviation (mm)
X	.009	±0.02
Y	.020	±0.02
Z	.050	±0.02

1.04 Scan Speed:

The system must support a minimum laser scan speed of **3.0 m/s**.

1.05 Build Material Layer Thickness:

The system must allow for a selectable layer thickness option with a minimum layer thickness of **100 µm** (±20 µm tolerance).

1.06 Manual Layer Thickness Adjustment:

The system must enable operators to manually adjust the layer thickness within a range of ±10% through the software interface, allowing optimization for different materials and print quality requirements.

1.07 Material Specification – Polymer Powder:

The system must be compatible with 100% polyamide materials, as well as polyamide-based composites with additional added components that modify material properties.

The build material shall be a high-performance thermoplastic polymer powder suitable for additive manufacturing.

The system shall allow recovery and reuse of unused powder from the build process wherever it is feasible.

2.0 Process Software Specifications

2.01 Material-Specific Process Profiles:

The process software must include pre-configured material profiles to optimize key printing parameters including laser power, scan speed, temperature profiles, and layer thickness for all materials supported by the system.

2.02 Customizable Parameters:

The software must allow users to adjust parameters including laser power, scan speed, and layer thickness to fine-tune settings for specialized applications.

2.03 Real-Time Monitoring and Quality Assurance:

Process Monitoring: The software must provide real-time tracking of critical process variables, including temperature, laser performance, and material flow, to facilitate adjustments during the print process.

Error Detection: The software must include integrated error detection tools to identify and address anomalies (including temperature fluctuations and material inconsistencies) during printing.

Comprehensive Quality Reporting: After each print cycle, the software must generate Part Quality Reports assessing dimensional accuracy, surface finish, and material properties for traceability and quality control.

2.04 Layer Thickness Control:

The software must allow for layer thickness adjustment with a minimum layer of 0.1 mm, and increase from that based upon the operator determination.

2.05 The system must be equipped with a graphical interface (GUI) that displays real-time print status

3.0 Slicing Software Specifications

The System must include slicing software that accurately converts 3D models into printable layers. It should support fine resolution control and allow for slicing based on user-defined parameters including layer height, laser power, and scan speed.

3.01 Slicing Functionality:

STL file sliced layers thickness from

a minimum of 0.05 mm to 0.2 mm

3.02 Scaling and Resizing Tools/features:

Uniform Scaling: The software must support uniform scaling along the X, Y, and Z axes.

Non-Uniform Scaling: The software must provide the ability to scale non-uniformly along individual axes (X, Y, or Z).

Automatic Scaling: The software should include automatic scaling features to fit models within the build volume, including compensation for material shrinkage.

3.03 Error Detection and Repair:

The software must include automated tools to detect and repair the following, ensuring the model is suitable for printing:

Inverted normals

Bad edges

Bad contours

Overlapping triangles

Intersecting triangles

Shell Noise

3.04

3.05 Layer Thickness Control:

The software must allow for layer thickness adjustment with a minimum of **100 microns** (0.1 mm), with a tolerance of ±10% to ensure flexibility in adjustment of print resolution and quality as well as optimization of the process for different materials and geometries.

4.0 Pre- and Post-Build Processes:

Details regarding pre- and post-build processes including powder preparation, part removal, cleaning, and finishing must be provided by the vendor to ensure safe and effective handling before and after the print cycle is complete.:

4.01 Pre-Build Preparation:

The system must include all equipment and means required for material preparation should a pre-build process be required prior to build start. This must include all tools and equipment required for powder preparation to include mixing and build operation setup.

4.02 Build Procedures: De-powdering / Breakout System:

The System must provide a hardware piece to allow removal of the completed build for transfer purposes to the post process area.

The system must include a dedicated breakout station for safe and efficient removal of parts to include unfused powder from the build area and completed parts.

The breakout station breakout station shall allow complete recovery of possible reusable powder in accordance with manufacturer guidelines, ensuring minimal contamination and powder loss.

4.03 Part Cleaning / Surface Preparation

The System must provide a bead-blasting cleaning station for the purpose of residual powder removal and surfaces preparation for inspection usage.

The station cleaning parameters shall provide operator control and or selection of the abrasive medium, pressure and nozzle tip size to avoid surface damage or dimensional distortion of printed parts.

The bead blasting cleaning station shall include dust collection and filtration systems compliant with industrial safety standards.

The bead blasting cleaning station shall include proper ventilation and dust extraction, to prevent exposure to the operator.

5.0 Installation Specifications

The vendor shall be responsible for the delivery, installation, and full commissioning of the Selective Laser Sintering (SLS) 3D printer system at the LASR Facility, B 271 of the Naval Research Laboratory, 4555 Overlook Ave. SW Washington, D.C., in compliance with the following specifications:

5.01 Room Dimensions: The room dimensions and door openings are as follows: Room 26’ x 13’ Door opening 47”.

5.02 Delivery and Setup

Delivery: The vendor shall coordinate delivery of the SLS printer to the LASR Facility, B 271 Room 131, ensuring that all components of the system, including hardware, software, and associated materials, are delivered in their entirety and undamaged.

Delivery Timeline: The system must be delivered within 60 calendar days of contract award, unless otherwise specified by the government.

Installation Site Readiness: The government will provide the vendor with room layout, space dimensions, and electrical requirements prior to installation. The vendor must ensure the printer's installation is compliant with the available space, power supply, and environmental conditions specified by NRL.

5.03 Installation Requirements

Power Supply: The system must operate on 208V AC (single-phase) or 120V AC (as specified by the vendor) electrical circuits. If the provided voltage supply is insufficient for the printer's operational requirements, the vendor shall be responsible for providing and installing the necessary transformers to ensure that the system receives the correct voltage as per the printer's specifications.

Power Conditioning: The vendor must provide recommendations for surge protection, power conditioning, and backup solutions, if required, to ensure stable and reliable operation of the system.

5.04 System Assembly and Setup

Installation of Hardware Components: The vendor must perform full assembly and setup of the SLS printer, ensuring all mechanical components are properly aligned and installed according to manufacturer specifications.

Calibration: The vendor shall calibrate the system, including all laser alignment, focus adjustment, and other critical setup processes, to ensure the machine operates within specified tolerances for part resolution, accuracy, and overall performance.

Software Installation and Configuration: The vendor must install and configure the process software, slicing software, and any required auxiliary software on the designated workstation. The software must be fully integrated with the hardware for seamless operation.

System Testing: After installation, the vendor shall conduct an initial test print to verify system functionality, including laser operation, material flow, part accuracy, and software operation. The test should confirm the system meets the minimum build specifications, part resolution, and layer thickness as outlined in the contract.

5.05 Documentation and Handover

Upon completion of the installation, the vendor must provide all relevant documentation, including but not limited to:

Installation Checklist (signed by both vendor and NRL representative)

System Setup Manual (including all assembly, calibration, and configuration steps)

Software Configuration Guide

Warranty Documentation

List of Spare Parts and Consumables

The vendor shall submit a **Certificate of Installation Completion**, confirming that the system has been fully installed, calibrated, and is operational according to technical specifications.

5.06 System Acceptance

The installation will be considered complete upon successful completion of the above steps, including the initial test print and operator training. The vendor must address any deficiencies identified by the NRL upon final inspection. Acceptance will be granted only after NRL confirms that the system meets all operational requirements and specifications.

6.0 Training

The vendor must provide training sessions for at least four individuals, with no fewer than 3 full days up to 5 full days of instruction. The training must be provided by a qualified technician of the printer manufacturer. The training must provide comprehensive, hands-on training to the designated operators at the LASR Facility. This training shall cover the following:

6.01 System Operation:

The Vendor shall provide instruction on the operation of the 3D printing system, including, but not limited to user interface navigation, machine controls, configuration of print parameters, material loading and handling, calibration procedures, and routine and preventive maintenance requirements.

6.02 Software Training:

The Vendor shall provide training on all necessary software related to the operation of the 3D printing system, including:

Part preparation and slicing software for file import, model orientation, support generation, parameter selection, slicing, and build file preparation.

Process/build management software for job setup, machine communication, build monitoring, parameter adjustment, data logging, and build execution control.

File management, workflow integration, and best practices for transitioning from CAD model to printed part.

The training shall include guidance on integrating the software into the workflow and managing files throughout the entire build process.

6.03 Additional Training

Machine component identification

System setup and calibration

Temperature checks and system diagnostics

System operation Including basic functions print settings material loading build monitoring error detection and troubleshooting

complete build removal, breakout and part cleaning machine cleaning and maintenance.

7.0 Documentation

7.01 The vendor must supply one complete printed set of the following manuals with the system upon delivery:

System Operations Instruction Manual including basic functions, print settings, material loading, and maintenance procedures

Processing Software Instruction Manual

Slicing Software Instruction Manual

Spare Parts Manual

Material Compatibility Manual

Maintenance Manual

Troubleshooting Manual

8.0 Technical Support

8.01 The vendor must provide standard phone technical support during normal business hours (9 AM to 5 PM) after government acceptance of the system.

8.02 The technical support must cover:

System operation and troubleshooting

Process software operation and troubleshooting

Part failure and hardware breakdown.

7.0 Maintenance and Warranty

7.01 The vendor must provide a minimum 1-year factory warranty covering all system equipment, parts and components, to include hardware and software, and all associated parts. The warranty must include coverage for:

Replacement parts

Labor

Travel expenses for on-site support and repairs

The warranty period begins after the system has been installed, training has been completed, and the system has been accepted in ERP by NRL.