



**Fusion and Fission Energy and
Science Directorate**
**Statement of Work – Graphite Rotary
Furnace for Kernal Fabrication**

Rev 0


Bldg. 4508,
Rm 242

AFF-SOW-01
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STATEMENT OF WORK

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1. SCOPE

1.1 Introduction

This document sets forth the Statement of Work (SOW) for services related to design, manufacturing, delivery, and support of a high-temperature graphite rotary furnace for use by the Advanced Fuel Fabrication Group at Oak Ridge National Laboratory (ORNL). The SOW establishes the technical, quality, safety, configuration, and acceptance controls required and is intended to serve as the contractual basis for the procurement of equipment capable of meeting strict thermal, gas, vacuum, and agitation requirements necessary for fuel kernel fabrication and thermal conversion research. (Seller) shall provide to UT-Battelle, LLC, the managing and operating contractor for The Oak Ridge National Laboratory (Company), pursuant to a contract with the U.S. Department of Energy (DOE) on a project known as Advanced Fuel Fabrication Group.

1.2 Background

The Advanced Fuel Fabrication Group develops a wide range of nuclear fuel forms that require high-temperature thermal conversions conducted under tightly controlled environmental and mechanical conditions. A graphite rotary furnace is required to provide both the temperatures and controlled material agitation needed to produce consistent, high-quality fuel kernels.

ORNL is seeking to expand its fabrication capability in both batch size and product quality. To meet this objective, the furnace must be capable of operating at very high temperatures, with programmable heating and cooling rates, controlled rotation, vacuum capability, and multiple process gas inputs. The system will be used for materials that are air-sensitive and that require controlled thermal and atmospheric environments for successful conversion

This SOW will be reviewed by procurement, compliance, legal, quality, and DOE oversight organizations and therefore must define requirements in a clear, auditable, and enforceable manner.


1.3 Work Description

The objectives of this subcontract are to:

- Provide ORNL with a high-temperature graphite rotary furnace capable of meeting all technical and operational requirements defined in the technical specifications.
- Enable safe, repeatable, and controlled thermal processing of fuel kernel materials.
- Deliver a system that is suitable for integration into ORNL laboratory operations and compliant with applicable safety, quality, and regulatory requirements.

The resulting equipment will be used to support research and development activities in nuclear fuel fabrication.

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2. ACRYOMNS & DEFINITIONS

ORNL	Oak Ridge National Laboratory
DOE	U.S. Department of Energy
NQA-1	ASME Nuclear Quality Assurance Standard (2008/2009a)
ACL	Acceptance Criteria Listing
BOM	Bill of Materials
FAT	Factory Acceptance Test
SAT	Site Acceptance Test
ESH	Environment, Safety, and Health
JHA	Job Hazard Analysis
SDS	Safety Data Sheet
NRTL	Nationally Recognized Testing Laboratory
OSHA	Occupational Safety and Health Administration
DAP	Delivered at Place (Incoterms shipping term)
PI	Principal Investigator
Manufacture	Broad, large-scale process of turning raw materials into finished, mass-produced goods.
Fabricate	Cutting, bending, and assembling raw materials to create specific components or structures.

3. APPLICABLE CODES, PROCEDURES, AND REFERENCES

- Rotary Furnace Technical Specifications v1.1
- Applicable ORNL, DOE, OSHA, and electrical safety requirements
- ASME NQA-1 (2008/2009a) or ORNL-approved equivalent


4. TECHNICAL AND FUNCTIONAL REQUIREMENTS

The system being supplied is a graphite rotary furnace for high-temperature conversions of large batches of material. The furnace must be programmable and vacuum capable, with a maximum temperature of 2000 C and maximum process gas flow rates of 10 SLPM. Full technical requirements are detailed in the Technical Specifications.

5. QUALITY REQUIREMENTS

The Seller shall maintain a Quality Assurance Program compliant with ASME NQA-1 (2008/2009a) or ORNL-approved equivalent for all activities that affect form, fit, function, or safety performance of the furnace system. Any proposed deviations shall be formally submitted and approved by

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ORNL prior to implementation and shall be incorporated into controlled configuration documentation. ORNL reserves the right to perform source surveillance and audits at the Seller or sub-tier facilities at any time. The QA program shall include documented controls for:

- Design control and verification
- Procurement and supplier qualification
- Identification and traceability of materials
- Fabrication, inspection, and test control
- Nonconformance reporting and corrective action
- Configuration management and change control

All safety-significant components (heating elements, graphite crucible, hot zone, gas manifolds, pressure boundaries, interlocks, control systems, and vacuum components) shall be **uniquely identified and traceable to material certifications and inspection records**. The Seller's QAP shall include a Suspect/Counterfeit Items Prevention Program compliant with DOE O 414.1. Independent inspection and verification shall be performed for critical characteristics, including dimensional, functional, pressure, temperature, electrical, and interlock performance. All nonconformances shall be documented, and the Customer shall be notified as soon as possible. Any nonconformances shall also be summarized in the final data package.

5.1 Source Surveillance

As part of the Company's Quality Assurance Program, source surveillance activities may be conducted as deemed necessary by the Company to assure quality objectives are met. Such surveillance may include, but will not be limited to, auditing and monitoring of production and/or fabrication processes, in process inspection and controls, chemical and/or physical certifications, final inspections and tests, preparation for shipment, and review of certification data. The Seller and its subcontractors shall provide Company representatives access to all data and operating areas, involved in the performance of the Agreement. Source surveillance by the Company representative shall not constitute product acceptance by the Company and shall in no way relieve the Seller of responsibility to furnish acceptable items.


5.2 Material Mill Certificate

Material Certification such as those stipulated through ASME, ASTM, SAE, etc., and Material Test Reports shall be submitted identifying the specification to which the material conforms. Specific test data obtained from the original mill source is required and shall include physical and chemical properties and other specified properties and testing. Certification shall include the signature of the Seller. All reports shall be subject to review by the Company.

5.3 Calibration Certification

The Seller shall submit with each instrument/system a certification that the instrument/system has been calibrated and is ready for use. The certification shall contain, as a minimum, the identification of (1) the instrument/system, (2) the calibration procedure used, and (3) the

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standards and/or equipment utilized for the calibration (traceability to the SI, ILAC MRA accreditation process, dates of test, and identity of items tested will satisfy this last requirement). Detailed support data shall remain on file by the Seller as required by the contract. Certification shall be signed by an authorized Seller representative.

5.4 Operating Instrument Calibration Report

This report details the calibration of operating instruments performed immediately prior to, or upon the initial installation into, the associate system. The report shall contain the signature and title of the authorized representative of the organization performing the calibration and shall be sent to the Company for review.

5.5 Nonconforming Items

The Company expects to receive equipment items, components, materials, and documentation that conform to all codes, standards, specifications, and procedures in the subcontract. The Seller may use its own-nonconformance program to identify, report, and recommend disposition of all non-conformances, but dispositions that would leave any remaining nonconformity must be submitted to the Company for approval.

The request should identify the affected item(s) by name and serial number, citing the drawing and/or specification number and revision number containing the specific requirement that has not been met.

The request should state the number of nonconforming items being reported. The request should include a description of the nonconformity, identifying requirement(s) not met. The supplier may attach a description of the cause, and a corrective action plan and schedule if pertinent.

The issuance and acceptance of such a request in no way limits or affects the warranty provision or other rights or remedies of this agreement. Such a request shall not establish a precedent or obligation to accept existing or future items not conforming to all provisions of the subcontract.


5.6 Assembly Parts List

The Seller shall furnish with each assembly a copy of an assembly parts list giving the part number and serial or lot control number of each part incorporated including any components or subassemblies furnished by the Company.

5.7 Seller Testing/Customer Witnessing

The system shall be tested and/or inspected at the Seller's site to ensure that all technical requirements of this specification have been met. The Company reserves the right to have a representative present during any manufacturing, assembly, test, inspection, or other activities

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associated with this system. The Seller shall notify the Company at least 30 days before conduct of system inspection and proof testing. Test and/or inspection activities shall be documented and provided to the Company’s representative prior to shipment of the system.

5.8 Packing and Shipping

The Seller is responsible for all packing and shipping provisions to ensure that the system arrives at the Company’s site in an undamaged, working condition. The Seller shall inform the Company of shipping plans two weeks before actual shipment.

5.9 Seller Installation and Start Up

The Seller shall provide qualified personnel to perform and oversee or oversee all system installation and start-up activities necessary to ensure the system is fully functional upon completion. In addition, the Seller shall provide personnel to provide comprehensive training necessary to operate the system to its full capabilities as stated in the technical portion of the specification.

5.10 Functional Test Report

This report of subsystems and systems, as installed, indicates the functional operability of such systems to design requirements. Such reports shall contain the signature and title of the authorized representative of the organization performing the tests and shall be sent to the Company for review and acceptance.

5.11 Final Acceptance

Final acceptance of the system shall be based on testing of the product to the technical requirements of the specification after completion of installation at the Company’s site.


5.12 Operating/ Maintenance Manual

Documents shall be submitted that contain the operational procedures, instructions, maintenance, spare parts list, and handling precautions.

5.13 Post-Installation Service & Maintenance

Service and maintenance shall be available from factory-trained service engineers, and to help ensure maximum safety for such activities, an established service network shall be in place. The service and maintenance contracts shall include routine maintenance visits (at least two visits per year) for cleaning and minor adjustments and emergency visits for inoperative equipment. Under such an emergency, the Seller's service personnel and any required replacement parts shall arrive at the installation site within two working days of notification by the Company that the equipment is inoperative. Replacement of critical system components shall be covered under

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emergency service.

6. PERFORMANCE REQUIREMENTS

NOTE:
The Seller shall provide monthly status reports to the customer throughout the duration of the below tasks

Task 1 – System Design and Engineering

The Seller shall design a high-temperature graphite rotary furnace system that meets all performance, safety, and functional requirements defined in the Technical Specifications (Section: Technical Specifications, Rotary Furnace Technical Specifications v1.1).

The design shall include:

- Furnace chamber, hot zone, and crucible configuration
- Heating, cooling, and temperature control systems
- Rotation drive and speed control systems
- Vacuum system and pressure control
- Process gas supply and mass flow control
- Control system with data logging
- Safety interlocks and protective features

Milestone(s):

- Preliminary design package and review meeting with the customer.
- Final design drawings and specifications (customer reviews and approves).

Task 2 – Design Baseline and Manufacturing Authorization

Establish the frozen, configuration-controlled product definition that authorizes manufacturing.

- Final drawings, BOM, interfaces
- Final ACL
- Final Hazard Analysis and Safety Controls
- Final Configuration Management Plan
- FAT Plan and SAT Plan
- Final Shipping and Installation Plan
- Training plan


Milestone:

- Submit above documents for customer approval

Task 3 – Manufacturing and Assembly

The Seller shall manufacture and assemble the furnace system in accordance with the approved design. All materials, components, and workmanship shall be suitable for high-temperature

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operation and compatible with graphite and process gas environments.

Milestone(s):

- Manufacturing start
- Factory assembly complete

Task 4 – Factory Acceptance Testing

The Seller shall perform functional and safety testing to demonstrate that the furnace meets all specified requirements. Testing shall include, at a minimum:

- Maximum operating temperature verification
- Ramp rate verification
- Rotation range verification
- Gas flow and pressure control verification
- Vacuum performance verification
- Interlock and alarm functionality

Testing shall be performed under controlled procedures approved by ORNL. All test instruments shall be calibrated and traceable to national standards. Test records shall be retained and submitted as part of the final data package.

A formal Factory Acceptance Test (FAT) shall be conducted, witnessed by ORNL (remote or in-person), and shall verify all safety, performance, and interlock functions. Any non-conformances shall be documented through a nonconformance process and resolved prior to shipment.

Milestone(s):

- Factory acceptance test (FAT) complete
- Functional test report submitted

Task 5 – Delivery and Installation

The Seller shall execute the final shipping and assembly plan for shipping and on-site assembly.

Milestones:


- Shipment delivery with satisfactory receipt inspection
- On-site assembly

Task 6 – Site Acceptance Testing

The Seller shall perform functional and safety testing to demonstrate that the furnace meets all specified requirements. Testing shall include, at a minimum:

- Maximum operating temperature verification
- Ramp rate verification
- Rotation range verification
- Gas flow and pressure control verification

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- Vacuum performance verification
- Interlock and alarm functionality

Testing shall be performed under controlled procedures approved by ORNL. All test instruments shall be calibrated and traceable to national standards. Test records shall be retained and submitted as part of the final data package.

A formal Site Acceptance Test (SAT) shall be conducted, witnessed by ORNL, and shall verify all safety, performance, and interlock functions. Any non-conformances shall be documented through a nonconformance process and resolved prior to shipment.

Milestone(s):

- Site acceptance test (SAT) complete
- Functional test report submitted

Task 7 – Final Acceptance and Training

The Seller shall address and correct any non-conformances or discrepancies discovered in the SAT. The Seller shall provide a final data package and closeout report indicating that the furnace operates fully in accordance with the Technical Specifications and design requirements.

The Customer shall review and approve the final data package and closeout report as final acceptance.

The Seller shall provide a plan to conduct hands-on training for Customer personnel on the functional operation and use of the equipment.

Milestones:

- Final data package and closeout report
- Training
- Submit training record

7. DELIVERABLES/SUBMITTALS

Milestones

Task	Milestone	Due
Task 1	Preliminary design submitted	Due Date per TPO Approval
Task 1	Final design approved	Due Date per TPO Approval
Task 2	Baseline & fabrication authorization by TPO	Due Date per TPO Approval
Task 3	Factory assembly complete	Due Date per TPO

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Task	Milestone	Due
		Approval
Task 4	FAT complete and functional test report submitted	Due Date per TPO Approval
Task 5	Shipment delivery with satisfactory receipt inspection	Due Date per TPO Approval
Task 5	On-site assembly	Due Date per TPO Approval
Task 6	SAT complete and functional test report submitted	Due Date per TPO Approval
Task 7	Final data package and closeout report	Due Date per TPO Approval
Task 7	Training (submit record)	Due Date per TPO Approval

Deliverables

Deliverable	Description	Schedule
1	Project Quality Assurance Plan & Project Schedule	Within 2 weeks after award
2	Seller Requested Deviations List (if any)	Within 2 weeks after award
3	Preliminary Design Review (PDR) Package	≤ 3 months after award
4	Final Design Baseline & Fabrication Authorization Package	≤ 3 months after PDR
5	Factory Acceptance Test (FAT) Data Package	Prior to shipment
6	As-Built & Configuration Records	Prior to shipment
7	Furnace System (Delivered Hardware)	Upon delivery to ORNL
8	Installation & Commissioning Package	Prior to on-site work
9	Site Acceptance Test (SAT) Report	After installation
10	Operations, Maintenance & Training Package	At SAT completion
11	Final Data Package & Closeout Report	Within 30 days of SAT completion

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