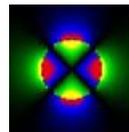


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Magnet Division Procurement Specification

Specification Number: SMD-LARP-RD2001

Revision: A



Superconducting
Magnet Division

Long Reaction Oven, Procurement Specification For

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1.0 SCOPE:

This specification establishes the overall requirements for the procurement of the Long Reaction Oven for use on the Long Racetrack Coils - LARP (LHC Accelerator Research Program)

2.0 GENERAL DESCRIPTION:

The oven shall be a high temperature oven to be used for the heat treatment in a 100% argon atmosphere of coils comprised of Nb₃Sn superconductor. These coils shall be constrained in a stainless steel retort/reaction fixture during heat treatment and shall be instrumented with temperature sensors in critical areas. Gas connections to the retort/reaction fixture which penetrate the oven shall be used to maintain an argon purge of the interior of the fixture from an external source during heat treatment.

Temperature uniformity of the reaction fixture at 210 °C, at 400 °C, and at the maximum heat treatment temperature range (~650 °C) is critical (see 3.2) and shall receive appropriate consideration in the detailed design of the oven and its control system.

3.0 TECHNICAL REQUIREMENTS:

The design of the Long Reaction Oven shall include, but not necessarily be limited to the features, operating requirements and characteristics as specified herein. It shall be designed to best commercial practices and shall be constructed in a thoroughly workmanlike manner.

3.1 Operating temperature:

- Desirable > 675 °C
- Acceptable = 675 °C

3.2 Temperature uniformity

Temperature uniformity of the working volume (including the thermal load mass) at 210 °C, at 400 °C, and at 650 °C shall be as follows:

- Desirable +/- 3 °C
- Acceptable +/- 5 °C

The use of fans to circulate the atmosphere within the oven in order to enhance temperature uniformity and to reduce the time delay at 650 °C is acceptable.

3.3 Maximum time delay at 650 °C:

This is the maximum time before the entire working volume (including the thermal load mass) shall be within the temperature uniformity range specified herein, at the end of a ramp from 210 °C to 650 °C at 50 °C/h with a thermal load mass of 1000 Kg (250 Kg/m over 4 m length).

- Desirable < 5 hours
- Acceptable = 5 hours

During this time period the temperature within the oven working volume may exceed the set point, but the load temperature shall not be permitted to overshoot the set point.

3.4 Temperature ramp-up rate:

Oven power shall be sufficient to ramp from 20 °C to 650 °C at specified rate with maximum load as follows:

- Desirable: 200 °C/h
- Acceptable: 100 °C/h

3.5 Maximum load:

The load shall be a stainless steel retort/reaction fixture containing coils made of Nb₃Sn and copper

- Desirable > 250 Kg/m over a 4m working volume
- Acceptable = 250 Kg/m

3.6 Working volume:

This is the volume, in the center of the oven, where the temperature uniformity shall be maintained as specified herein. The door opening and internal oven dimensions shall be large enough to accommodate objects of this size with reasonable clearance for additional fixture supports, thermocouple wiring and argon plumbing as necessary. The seller shall specify the overall oven internal dimensions and door opening size.

- Length: 4 m
- Cross-section: 0.5 m x 0.5 m
- Shorter objects (e.g. 1-2 m long) will also be heat treated in this volume

3.7 Oven and retort/reaction fixture atmospheres:

- The oven shall have suitable gas penetrations to allow for purging the interior of the retort/reaction fixture to establish a 100% argon atmosphere within the fixture before heat treatment and to maintain the purge during the heat treat cycle. The seller shall specify the applicable oven components including, but not necessarily limited to the following:
 - Oven sealing
 - Door sealing
 - Pipes for argon input and output (see 3.9.2)
 - Penetrations for thermocouple leads (see 3.9.2)
 - Vent and overpressure protection provisions
- The seller shall specify the selection of heating element materials as it applies to compatibility with the atmosphere within the oven
- The seller shall discuss oven venting and sealing provisions as required to prevent the intrusion of external, unheated air from degrading the temperature uniformity within the oven during the heat treat cycle. In addition the seller shall discuss the adequacy of the proposed oven sealing scheme to provide sufficient sealing to enable an optional positive pressure inert gas (argon) purge of the atmosphere within the oven prior to and during the heat treat cycle. Discussions shall include, but not necessarily be limited to such pertinent factors as;
 - the cost and schedule impact of providing enhanced sealing capability if required to enable positive pressure purging of the atmosphere within the oven
 - estimated required purge gas flow rate
 - affect of purge gas flow on temperature uniformity
 - achievable internal oven pressure during purge
 - control of the purge gas flow/pressure
 - location of purge gas inlet and outlet connections

3.8 Control system:

The control system shall be network compatible and shall have supportable and patchable operating system, Windows XP with SP2. Possible system architecture is as follows: a controller with any operating system, connected via GPIB (or other dedicated connection) to a PC with Windows XP and SP2

- The control system shall provide for both manual and automatic control
- The temperature measuring system shall have an absolute accuracy of +/- 1°C at 210 °C, at 400 °C, and within the range 600-700 °C. The seller shall specify accuracy outside this range
- The temperature measuring system shall have a minimum sensitivity of 0.1 °C
- The control system shall provide for control of a minimum of 4 independent zones (depending on zone division of heaters suggested by the seller in order to meet temperature uniformity requirements specified herein)
- The control system shall allow change of set-point temperature during operation
- The control system shall allow displaying, recording and remote viewing of 20 temperature sensors
- The control system shall allow use of external (user supplied) temperature sensors for multiple control loops
- The control system shall allow for the use of advanced control schemes including cascade, rate limits, real-time mathematical functions, etc.
- The control system shall have sufficient non-volatile memory to store all temperature recordings at 1 minute intervals over a 20 day period
- The control system shall store programs and settings through indefinite power outages
- An over-temperature interlock shall be provided
- The control system shall have the capability of alarming on any out-of-specification condition
- A discrete output shall be provided for alarm conditions capable of driving a small relay
- If an internal circulation system is employed, system operational status indicators shall be provided

3.9 Other:

3.9.1 Loading System: The seller shall propose a loading system to facilitate moving the load into and out of the oven. The detailed design of this system shall be determined by the configuration of the proposed oven and shall be capable of safely operating with maximum loads as specified herein.

3.9.2 Penetrations: The oven shall be provided with penetration ports for thermocouple wires and argon pipes. The ports shall be configured and located so as to facilitate connection of the retort/reaction fixture argon piping and fixture-mounted thermocouples after insertion of the fixture into the oven.

- Penetrations shall be provided for up to 16 thermocouple pairs
- Penetrations shall be provided for argon inlet and outlet pipes for connection to the retort/reaction fixture
- Suitable closures for un-used ports shall be provided
- In addition, if the optional capability to purge the atmosphere within the oven is selected for implementation, the oven shall be provided with argon inlet and outlet connections as appropriate

3.9.3 Documentation: The following documentation shall be provided by the seller:

- User manuals (including instructions for start-up, operation, maintenance and trouble-shooting) for the oven and control system
- Complete as-built drawings including wiring diagrams
- Control system source files if applicable
- Copies of reports of all required inspections and tests
- Recommended spare parts list

3.9.4 Power requirements: Power supplied shall be 480 VAC, 3 phases, 4 wire, 60 Hz.

3.9.5 Safety:

- The oven shall meet all applicable OSHA requirements as well as all applicable federal, state and local codes.
- The oven shall be listed by an OSHA approved Nationally Recognized Testing Laboratory (NRTL).
- The oven shall not contain asbestos or asbestos containing material.

3.9.6 Installation: The seller shall be responsible for installation, activation and successful acceptance testing of the oven at Brookhaven National Laboratory, Upton, NY

4.0 OPTIONS:

The seller shall quote the following options:

- On site start-up service at Brookhaven National Laboratory (seller support of first item production run)
- Description and costs of service and maintenance options
- Requirement to continue to operate normally on an external generator (customer supplied) subsequent to an unplanned power outage occurring at any point in the heat treat cycle
- Ability to maintain a positive pressure argon purge of the atmosphere within the oven prior to and during the heat treat cycle (see 3.7)

5.0 QUALIFICATION TESTS:

5.1 Test requirements: The oven shall pass qualification/acceptance testing at the seller's facility and upon completion of installation at Brookhaven National Laboratory. Testing shall demonstrate as a minimum all applicable requirements set forth in this specification. Testing shall be performed by the seller and witnessed by BNL representatives. Before testing shall begin, the seller shall submit a written Acceptance Test Procedure (ATP) to BNL for approval. Once approved, changes must be approved by BNL prior to implementation.

- One heat treatment cycle shall be performed during the qualification test utilizing a 4 meter long dummy mass of up to 1000 Kg. (provided by Brookhaven National Laboratory).
- The heat treatment cycles shall consist of the following :
 - Ramp to 210 °C at 100 °C/h minimum ramp rate
 - Hold for 24 hours
 - Ramp to 650 °C at 50 °C/h minimum ramp rate
 - Hold for 24 hours
 - Cool-down to room temperature at maximum rate (all heaters off)
- A minimum of 16 temperature sensors shall be placed in the working volume and on the thermal load by Brookhaven National Laboratory. All temperatures shall be recorded during the complete thermal cycle.
- All requirements as set forth in this specification shall be met for acceptance, including, but not limited to:
 - Temperature uniformity inside the working volume at 210 °C, at 400 °C, and 650 °C
 - Maximum time delay at 650 °C
 - All features of the control system

Conformance to the requirements of this specification shall be demonstrated by observation, inspection, calculation, test, etc. as applicable.

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6.0 SELLER'S QUOTE:

The seller's quote shall include, but not necessarily be limited to the following:

- Any exceptions or qualifications to this specification. The seller may propose alternatives where cost, schedule and/or performance improvements may be realized
- Description and drawings of the general arrangement of the oven and loading system
- Description of loading procedure
- Drawings of penetration ports and their closures
- Description of procedure for insertion of thermocouple wires through the ports and closing of ports to establish gas tight operating conditions
- Maximum power requirements
- Specification of temperature measurement system used by the control system
- Warrantee description