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Magnet Division Procurement Specification

Superconducting Magnet Division

Specification Number: SMD-MAG-RD2002

Revision: A

Procurement Specification For 16 Tesla Magnet,

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Revision History

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1.0 SCOPE:

This specification establishes the overall requirements for the procurement of a complete 16 Tesla superconducting magnet system for use in the wire testing facility.

2.0 GENERAL DESCRIPTION:

The magnet system shall include a high field magnet with an aperture for testing superconducting wire samples. The system shall include a power supply and a liquid helium cryostat to allow operation and critical current testing at 4.2 K. The complete system shall be installed and demonstrated by the vendor.
Central flux density is critical and shall receive appropriate consideration in the detailed design of the magnet system.

3.0 TECHNICAL REQUIREMENTS:

The design of the magnet system 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 Magnet:

- Magnet shall be a superconducting magnet operating at 4.2K in liquid helium.
- Magnet shall be fully protected to permit the safe release of stored energy under all circumstances without any damage to the magnet.
- Minimum central flux density: 16 Tesla at 4.2K.
- Field Homogeneity along the surface of a 40 mm diameter cylinder shall be less than 0.2% for a length of 50 mm and less than 1.0% for a length of 150 mm
- Minimum clear bore diameter: 45 mm
- Minimum ramp rate: 1.6 Tesla/minute (or 10 mins. to full field)
- Vapor cooled current leads shall be included.
- Maximum operating voltage: +/- 10 V
- Magnet shall be capable of persistent mode operation.

3.2 Helium Cryostat:

- Magnet shall be suitably supported inside a helium cryostat. It shall be supported in such a way that it can be easily removed when necessary. Support system requires a minimum safety factor of 3 to 1 based on material yield strength.
- Cryostat shall be vacuum jacketed and shall include vapor cooled shielding.
- Cryostat shall not include liquid nitrogen shielding.
- Cryostat shall be constructed of non-magnetic materials.
- Cryostat shall be capable of holding a minimum vacuum level of 10 mTorr

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- Cryostat shall be rated for operation at a maximum pressure of 5 psi. (*normal operating condition is 1 atm.*)
- Minimum liquid helium capacity: 45 liters
- Suitable pressure relief valve shall be included for the helium vessel.
- Suitable pressure relief valve shall be included for the vacuum jacket. Vacuum jacket pressure relief shall be sized to protect the jacket in case of helium leak into jacket.
- Maximum helium consumption rate: 1 liter/hr static (no ramping), 5 liter/hr ramping mode.
- Maximum cryostat height (ground level to top flange): 1.7 m
- A standard bolted flange shall be provided at the top of the vessel for installation / removal of test sample holder.
- Helium cryostat shall meet ASME pressure vessel code requirements. An ASME stamp is highly desirable.
- The vessel shall have suitable penetration ports for:
    - Evacuation
    - Helium filling
    - Helium gas return
    - Pressure relief

- Evacuation, fill and return ports shall include-quick disconnect fittings.
- One 1.33” Conflat shall be provided for instrumentation feedthrough.
- Helium vessel shall include lifting lugs. Lifting lugs require a minimum safety factor of 3 to 1 based on material yield strength.

3.3 <u>Power supply</u>:

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- Power supply should be designed for the operation of low-resistance high inductance superconducting load.
- Power supply shall be capable of current setting to 1 mA via computer interface.
- Isolated voltage programmability is desirable.
- Power supply shall include isolated current signal read-back, 0-10 V full scale.
- Minimum current stability: +/- 6 mA / K
- Power supply shall be capable of bipolar operation with smooth ramp through zero-current.
- No current overshoot is acceptable while parking at target current setting.
- Power supply shall include digital display of field and current.
- Power supply shall include RS232 , IEEE (or USB) and Ethernet interfaces
- Power supply shall be rack mountable.
- Minimum power lead length: 6m
- Power supply shall include switch heater control for persistent current operation.

3.4 <u>Level probe</u>:

- A liquid helium level probe shall be included.

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- Level probe shall include a rack mountable digital display.
- Level probe readout shall include RS232, and IEEE (or USB) and Ethernet interfaces.
- Minimum level probe lead length: 6m

3.5 Temperature sensors:

- 2 temperature sensors shall be included, one at the top, the other at the bottom of the magnet.
- Temperature sensors shall have an absolute accuracy of +/- 0.01 K at 4.2 K.
- Temperature sensors shall have a minimum sensitivity of 0.005 K.
- CERNOX thermometers are preferred.
- Temperature sensors shall include a rack mountable digital display.
- Temperature readout shall include RS232 , IEEE or USB and Ethernet interfaces
- Minimum temperature sensor lead length: 6m

3.6 Power requirements:

- Complete system power requirements shall not exceed 3ph, 240 Vac, 60 hz.

3.7 Documentation:

The following documentation shall be provided by the seller.

- User manuals (including instructions for start-up, operation, maintenance and trouble-shooting) for the magnet, power supply and instrumentation systems.
- Complete as-built drawings including wiring diagrams.
- Magnetic field-Current calibration.
- Analysis of magnet support system.
- Analysis of the cryostat lifting lugs.
- Analysis of the relief valve requirements.
- Material certifications for all helium vessel materials.
- Results of vacuum and pressure testing.
- Relief valve capacity for the helium vessel.
- Relief valve capacity for the vacuum jacket.
- Stray field map with installation site limitations.
- Control system source files if applicable.
- Copies of reports of all required inspections and tests.
- Weld procedures and sample (coupon) test results.
- Recommended spare parts list.

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3.8 Installation:

- The seller shall be responsible for installation, activation and successful acceptance testing of the magnet system at Brookhaven National Laboratory, Upton, NY.

3.9 Safety:

- The magnet system shall meet all applicable OSHA requirements as well as all applicable federal, state and local codes.
- The helium vessel shall meet ASME pressure vessel code.
- The power supply shall be listed by an OSHA approved Nationally Recognized Testing Laboratory (NRTL), e.g. UL listed.

4.0 ACCEPTANCE TESTS:

4.1 Test requirements:

The system 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 leak check, cool down and power cycle shall be performed during the qualification test. Magnetic field shall be checked utilizing a suitable probe.
- All requirements as set forth in this specification shall be met for acceptance.

5.0 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 magnet system.
- Description of the stray field profile in all directions.
- Maximum power requirements.
- Warranty description.