CLS General Magnet Specification

CLS31-001 Rev. 1

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REVISION HISTORY

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A	04 August 1999	Draft	Daniel S. Lowe, P.Eng.
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1	1 December 1999	Added line items 2.1.2, 2.1.11,2.1.12, 2.2.7 to 2.2.12, 2.6.1.1, 2.6.1.2, 2.9.2.1.5	Daniel S. Lowe, P.Eng.

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1. INTRODUCTION

1.1 Purpose

This document specifies the requirements of a Proponent to supply magnets for use in the Canadian Light Source facility.

1.2 Scope

This specification covers the technical details to design and fabricate CLS magnets.

1.3 Background

The Canadian Light Source, CLS, is a national facility in the initial phase of construction on the University of Saskatchewan campus in Saskatoon, Saskatchewan. This facility is a 3rd generation synchrotron light source, which will produce a high intensity source of infrared, visible, ultraviolet and x-ray radiation.

2. REQUIREMENTS

2.1 Functional Requirements

2.1.1 The magnet shall be fitted with a minimum of 3 lifting fixtures.

2.1.2 All fasteners shall adhere to American National Standard for size and strength.

2.1.3 Temperature switches and terminal strips shall be fitted to the magnet.

2.1.4 Coils shall contain no splices.

2.1.5 Each coil shall have a temperature switch wired into interlock chains (one per coil), and connected to the terminal strips.

2.1.6 Demineralised water will be used to cool the magnets, therefore all metallic parts of the cooling system must be made of copper, zinc-free bronze, or stainless steel.

2.1.7 The Proponent shall provide CLS with the epoxy system, and documents verifying radiation hardness for CLS approval. The choice of the epoxy system has a large effect on how the coil ages in a radiation field. Alumina filler in the epoxy is not required.

2.1.8 Each coil shall be identified by a unique number written onto the coil surface, as defined in the labelling and numbering section,. This number must be used on all records and tests.

2.1.9 Coils shall be centered around the pole.

2.1.10 Coils shall be mounted on each pole using a insulating barrier to prevent the epoxy from rubbing directly onto the yoke steel.

2.1.11 The terminal blocks for the power cable connections shall be attached to the yoke and designed such that the total weight of the power cable is supported by the yoke.

2.1.12 Busses shall be electrically isolated from the core with US designation NEMA G-10, or equivalent epoxy fibreglass block.

2.1.13 Connections for coil cooling water shall be made using American Standard Unified thread Swage-lok fittings.

2.2 Performance

2.2.1 Each magnetic element will be fiducialised with no less than 4 points.

2.2.2 Fudicial bushings should have an internal diameter of 8mm, and an external diameter of 25mm.

2.2.3 Fudicial bushings shall be welded to the magnet top or as indicated in reference drawings supplied.

2.2.4 CLS supplied LCW will have a conductivity less than 6 μS/cm.

2.2.5 Water velocity within cooling coils shall not exceed 1.5 m/s.

2.2.6 Water cooled coils shall be designed to operate at a head of 1 MPa.

2.2.7 Water manifolds shall be fabricated using AISI 304 passivated stainless steel.

2.2.8 Loctite PST shall be used for all joint sealing purposes.

2.2.9 Teflon tape shall not be used for water fitting joints.

2.2.10 No plastic shall be used within the assembly.

2.2.11 Coils shall be formed from annealed copper conductor, to minimize winding and bending difficulties.

2.2.12 Microtherm B11-C71-U155 thermal switches shall be mounted on all coils. These shall be placed adjacent to the conductor, and shall open the primary contactor before the maximum junction temperature of 71°C is reached.

2.3 Safety and Environmental

2.3.1 The nominal operating temperature within the CLS shielding tunnel shall be 27°C with a minimum temperature of 20°C and a maximum temperature of 35°C.

2.3.2 The nominal operating temperature external to the CLS shielding tunnel shall be 22°C with a minimum temperature of 15°C and a maximum temperature of 35°C.

2.3.3 The relative humidity will be a minimum of 25% during the winter months, and a maximum of 50% during the summer months.

2.4 Applicable Codes, Standards and Procedures

Not applicable.

2.5 Quality Assurance

2.5.1 Proponent shall provide CLS with all quality assurance programs in use by the Proponent.

2.5.2 Predelivery Inspection and Testing at Proponent's Facility. The Proponent shall perform inspections and tests on all components at the Proponent's facility to assure all structures conform to this specification.

2.5.3 Source Inspection. CLS representatives shall be permitted to witness all manufacturing and testing operations herein required. When so requested, Proponent shall notify CLS 15 days prior to the performance of any test operation requested to witnessed.

2.5.4 CLS shall inspect and test some or all components after delivery. Successful completion of the inspections and tests to verify compliance with this specification shall be the basis for final acceptance

2.6 Inspection, Testing and Commissioning

2.6.1 Conductor

2.6.1.1 Prior to winding, each length of conductor shall be tested by blowing a sizing steel ball with 75% diameter of the cooling channel through the coolant passage using compressed air or water.

2.6.1.2 A visual inspection of the conductor, to locate any flaws, shall be performed prior to winding the coil.

2.6.2 Steel Sub-Assemblies

2.6.2.1 The completed sub-assembly shall be inspected for length and squareness and the measurements recorded. The pole gap of the completed steel sub-assembly shall be measured and recorded.

2.6.3 Coils

2.6.3.1 The coils shall not be shipped, until the CLS has witnessed the tests and/or received the test documentation and given written authorization for shipping. Failure of a coil to pass any test may, at the discretion of the CLS, cause the coil to rejected.

2.6.3.2 The completed coils shall be checked for dimensional compliance with the drawings and the quality of the epoxy insulation. The coils shall be free of cracks and voids.

2.6.3.3 Each coil shall be tested for shorted turns. The test voltage shall be 10 volts per turn or greater. The test method is the responsibility of the contractor and must be submitted for approval to the CLS. The CLS will either approve the method or not. Any manufacturing or testing prior to the CLS's written approval will be at the Contractor's risk.

2.6.3.4 The resistance of each coil shall be measured and recorded using a method accurate to better than 1% and the resistance value shall be corrected to a temperature of 27°C.

2.6.3.5 Each coil shall be immersed in clean salt water using a metal lined tank for at least sixty minutes. Following the immersion the coil shall be raised so that the coil terminal are out of the water and the terminals dried. A voltage of 500V DC shall be applied between the conductor and the metal tank lining for at least 2 minutes. The insulation resistance between the conductor and the tank shall be recorded. If the insulation resistance is less than 10 MΩ, or behaves unstably, the coil is subject to rejection. The coil shall then be dried.

2.6.3.6 Temporary end connections shall be made to each coil and it shall be connected to a source of clean water.

2.6.3.7 The flow in each cooling circuit in each completed coil shall be measured and recorded.

2.6.3.8 The cooling channel of each completed coils shall be pressure tested at 2 MPa for ten minutes without showing evidence of leaks.

2.6.3.9 Following completion of these tests and prior to assembly, or shipment, the coils shall be emptied and blown dry of all water. An inspection is required to confirm that this has been done.

2.6.4 Completed Magnet Assembly

2.6.4.1 Each complete magnet assembly shall be tested as follows:

2.6.4.2 The pole position and gap shall be measured.

2.6.4.3 Prior to connecting the magnet to water the insulation resistance between the coils and the steel yoke shall be measured at 500 VDC and shall be greater than 10 MΩ. During this test the temperature interlock circuitry shall be connected to the steel yoke potential.

2.6.4.4 The magnet resistance (two coils in series) shall be measured and recorded using a method accurate to better than 1%, and the resistance value shall be corrected to a temperature of 27°C.

2.6.4.5 The insulation resistance between the temperature switch circuit and the magnet steel assembly shall be measured at 120 VDC and shall be greater than 10 meg-ohms. The operation of the temperature switches shall be verified by applying a suitable heat source to the conductor next to the switch and verifying that the circuit opens and resets.

2.6.4.6 The cooling circuit shall be pressure tested at 2 MPa for 30 minutes with no indications of leaks. If a leak does occur it shall be repaired and the test repeated.

2.6.4.7 The pressure drop required to achieve the required cooling flow in liters/minute shall be measured and recorded.

2.6.4.8 Following testing the magnets shall be emptied of water and the cooling circuits shall be blown dry to remove residual water. An inspection is required to confirm that this has been done.

2.6.4.9 The magnets shall not be shipped, until the CLS has witnessed the tests and/or received the test documentation and given written authorization for shipping.

2.6.5 Tests After Delivery

2.6.5.1 CLS may repeat any other tests described in this specification after delivery. CLS reserves the right to return to the manufacturer any magnet or component that fails to pass these tests, the cost of transport being borne by the contractor.

2.7 Reliability and Maintainability

Not applicable.

2.8 Layout

Not applicable.

2.9 Other Requirements and Constraints

2.9.1 Documentation

2.9.1.1 Documentation shall conform to CLS Documentation Specification CLS01-001.

2.9.2 Labelling & Colours:

2.9.2.1 Component identification and colour

2.9.2.1.1 All elements shall be labelled with a permanent unique serial number following the form outlined in the referencing document.

2.9.2.1.2 The serial number label shall be visible from exterior.

2.9.2.1.3 The serial number label size should be 36 point.

2.9.2.1.4 Coils shall be unpainted.

2.9.2.1.5 Pole tips shall be unpainted, and protected with a rust preventative such as Lps-3 rust preventative oil or equivalent accepted by CLS.

2.9.2.1.6 Dipole elements should be painted royal blue.

2.9.2.1.7 Quadrupole elements should be painted forest green.

2.9.2.1.8 Sextupole elements should be painted maroon.

2.9.2.1.9 Orbit correction elements should be painted yellow.

2.9.2.2 Preparation for shipment and delivery.

2.9.2.2.1 The Proponent shall package all fabricated components to insure acceptance and safe delivery by common or other carrier, and so components can be delivered in an undamaged condition.

2.9.2.2.2 All shipping containers shall be marked or tagged with the following information:

2.9.2.2.2.1 CLS purchase order number

2.9.2.2.2.2 Shipping address as specified within contract

2.9.2.2.2.3 Proponent's name

2.9.2.2.2.4 Components contained within package

2.9.2.2.2.5 "Top-side up" if required

2.9.2.2.2.6 "Fragile" if required

3. REFERENCES

Not applicable.