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Large Hadron Collider
Magnet Division Procedure

Proc. No.: LHC-MAG-R-1034

Issue Date: Oct. 16, 2000

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Class: Dipole Cold Mass Assembly
Title: LHC D1 Electro-Mechanical Assembly

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- ES&H Review: Signature on File

REVISION RECORD

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1 Scope:

This specification describes the procedure for electro-mechanical assembly of the LHC D1 dipole magnet after the shells and endplates are installed.

2 Applicable Documents

The following documents, of the issue in effect at the time of release for manufacture, form a part of this procedure to the extent specified herein:

RHIC-MAG-R-7242 RHIC Dipole Hypot Testing

RHIC-MAG-R-7243 RHIC Dipole Low Precision Resistance Insulation Test

RHIC-MAG-R-7320 RHIC Dipole Electrical Resistance Measurement for Collared Individual Coils and Connected Coil Sets

RHIC-MAG-R-7393 RHIC Dipole Final Electrical Testing of Cold Mass

RHIC-MAG-R-7306 RHIC High Precision Resistance Insulation Test

RHIC-MAG-Q-1004 Discrepancy Reporting Procedure

Drawings

BNL Dwg. No. 14010088 D1 Dipole Electro/Mechanical Assembly

BNL Dwg. No. 14019007 D1 Dipole Wiring Diagram

3 Requirements:

3.1 Material/Equipment

NGC Dwg. No. 12010004-WF-3 Solder Fixture, Crossover

NGC Dwg. No. 12010004-TF-3 Tinning Fixture, Crossover Leads

NGC Dwg. No. 12010004-WF4 Solder Fixture Flex Jt-to-Midplane Leads

BNL Stock No. E-53912 Ethyl Alcohol

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3.2 Safety Precautions

3.2.1 Some of the electrical test procedures have specific safety requirements. The technicians performing these specific tests shall rigorously follow all the safety requirements listed as well as those prescribed by the BNL ES&H Standard.

3.2.2 Hypot and impulse testing pose a Class "C" electrocution hazard. At least two properly trained technicians must be present to perform this testing. When testing, a trained technician shall be stationed at any point where the item under test is accessible to unauthorized people, and barriers shall be set up. Signs shall be posted reading "DANGER HIGH VOLTAGE" and warning lights shall be turned on.

3.2.3 Specific steps of this procedure contain Electrical & Mechanical Assembly operations that impact the environment. Prior to performing these steps, personnel shall complete the applicable facility specific environmental training.

3.2.4 Eye protection should be worn when removing flux, especially on hot surfaces. If surfaces are above 140F, thermally insulated gloves (such as welder's gloves) must be worn to protect from burns.

3.3 Procedures:

3.3.1 Check that the setscrew torqueing procedure has been completed at both ends

3.3.2 Crossover Joint (Post Leads)

3.3.2.1 Install the crossover solder fixture on the right side of the lead end plate. Test for correct fit and mark cut location by forming the upper and lower coil leads into the fixture, with the superconducting cables in 3" contact with each other, and the copper cables on either side of this splice. Use the tinning fixture to tin the leads to the correct shape.

CAUTION

Hot Surfaces

Personnel Injury from Burns

Gloves should be worn if handling fixtures above 140F

NOTE

Ensure unused solder is recycled or disposed of properly

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- 3.3.2.2 Clean, trim, and install coil leads into the fixture with flux and solder ribbon as indicated on the assembly drawing.
- 3.3.2.3 Turn on the heaters. When the fixture reaches 450F tighten all the bolts and verify that the fixture is closed. Turn the heaters off and allow fixture to cool.
- 3.3.2.4 Disassemble and remove fixture when temperature drops below 200F. Remove excess flux from leads using alcohol.
- 3.3.3 Inspect Crossover
- 3.3.3.1 Crossover dimension .200" +.020" -.005" If joint is .002" to .005" or smaller than nominal 1201081-07 Kapton will be used to fill corresponding area of the G-1 cover.

NOTE

If G-10 is reworked it must be identified with the magnet no. using a non-conductive marker.

- 3.3.3.2 Strip back .2" of insulation from end of the appropriate color voltage tap wire.
- 3.3.3.3 Locate the voltage tap wire on lower coil lead near the center of the splice joint, and solder.

NOTE

Ensure unused solder is recycled or disposed of properly

- 3.3.3.4 Remove excess flux using alcohol.
- 3.3.3.5 Repeat steps 3.3.4.2 through 3.3.4.4 for the redundant voltage tap. The second tap shall be soldered on separately to prevent both taps from failing due to a single solder joint failure.

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3.3.4 Flex Joint Installation

3.3.4.1 Attach the flex joint support bracket to the lead end plate.

3.3.4.2 Install the flex joint.

3.3.4.3 Install the flex joint-to-lead solder fixture onto the lead end plate. Test for correct fit and mark cut location by fitting the coil leads into the fixture, with the superconducting cables in 3" contact with each other, and the copper cable against the copper terminal.

3.3.4.4 Clean, trim, and install coil leads into the fixture with flux and solder ribbon as indicated on the assembly drawing.

CAUTION

Hot Surfaces

Personnel Injury from Burns

Gloves should be worn if handling fixtures above 140F

NOTE

Ensure unused solder is recycled or disposed of properly

3.3.4.5 Turn on the heaters. When the fixture reaches 450F tighten all the bolts and verify that the fixture is closed. Turn the heaters off and allow fixture to cool.

3.3.4.6 Disassemble and remove fixture when temperature drops below 200F. Remove excess flux from leads using alcohol.

3.3.4.7 Repeat steps 3.3.5.3 - 3.3.5.6 for the adjacent flex joint-to-lead solder splice.

3.3.4.8 Strip back .2" of insulation from end of the appropriate color voltage tap wire.

3.3.4.9 Locate the voltage tap wire on coil lead approximately .75 inches from the endplate and solder.

NOTE

Ensure unused solder is recycled or disposed of properly

3.3.4.10 Remove excess flux using alcohol.

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- 3.3.4.11 Repeat steps 3.3.5.8 through 3.3.5.10 for the redundant voltage tap. The second tap shall be soldered on separately to prevent both taps from failing due to a single solder joint failure.
- 3.3.4.12 Repeat steps 3.3.4.8-3.3.4.11 for the redundant voltage taps on the adjacent flex joint solder splice.
- 3.3.5 G-10 Insulator Installation
 - 3.3.5.1 Wrap all the coil leads and splice joints with 2 layers of .002 in. kapton adhesive tape as shown on the assembly drawing.
 - 3.3.5.2 Install the crossover insulators and insulator covers as shown on the assembly drawing.
 - 3.3.5.3 Install the coil-to-flex joint insulators, insulator covers and mounting brackets as shown on the assembly drawing.
- 3.3.6 VT Resistor Mounting Board Installation
 - 3.3.6.1 Assemble and install the resistor mounting board with their terminals and resistors.
 - 3.3.6.2 Solder the six voltage tap wires from the splices from each bore to their assigned turrets as shown on the assembly drawing.

NOTE

Ensure unused solder is recycled or disposed of properly

- 3.3.6.3 At each turret, form the voltage tap wire into a .25" diameter loop and tie it to the turret as shown on the assembly drawing, using kevlar lacing cord and epoxy over the knot.
- 3.3.6.4 Connect the wires of the appropriate voltage tap lead harness to their respective terminals on the resistor mounting board and secure with lacing cord as shown on the drawing. The V-tap cable must be long enough to follow the circular shape of the flexible joint and exit out the "I" stub as shown.

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3.3.7 Block Heater Installation

3.3.7.1 Install the two block heaters on the lead end plate.

3.3.8 Instrumentation Wire Routing

3.3.8.1 Route all the instrumentation cables/wires to the flex joint as shown and secure them with Kevlar lacing cord at the locations shown on the assembly drawing.

NOTE

Wires included in this bundle are: eight diode temperature sensor wires in two 4-wire harnesses, six VT leads in two 3-wire harnesses, four block heater wires, and four quench strip heater wires.

3.3.8.2 Route the instrumentation cables/wires CCW along the front face of the flexible joint as shown. Secure the cables to the flex joint using fiberglass tape and Kevlar lacing cord at the locations shown on the assembly drawing.

NOTE

The instrumentation lead bundle is attached to the flex joint up to the 12 o'clock position after which it diverges from the flex joint and is routed separately, with the proper slack (see assembly Dwg.) and exits out the 1 inch diameter "I" stub located on the face of the lead end volume.

3.3.9 Post Assembly Electrical tests

3.3.9.1 Connect Beam Tube, Quench Protection Resistors & Iron to each other and to ground. Connect coils to each other and perform 5 kV Hypot between coils and ground per RHIC-MAG-R-7242 and RHIC-MAG-R-7243.

NOTE

The leakage current must be less than 50 μ a.

3.3.9.2 Perform resistance test between normal and redundant voltage tap wire at each point. Resistance to be 320S - 480S.

3.3.9.3 Perform Quench Protection Resistance test on each connected pair of resistors.

3.3.9.4 Connect Beam Tube, Coils & Iron to each other and to ground. Perform 5Kv Hypot between each connected pair of Quench Protection Resistors and ground per RHIC-

MAG-R-7242.

NOTE

The leakage current must be less than 50 μ a.

- 3.3.9.5 Connect Beam Tube, Coils, Iron & Quench Protection Resistors to each other and to ground. Perform 2Kv Hypot between each warm-up heater circuit and ground per RHIC-MAG-R-7242.

NOTE

The leakage current must be less than 50 μ a.

- 3.3.9.6 Perform temperature sensor to ground high precision insulation resistance test per RHIC-MAG-R-7306.
- 3.3.9.7 Perform DC resistance tests per RHIC-MAG-R-7320 to measure voltage drops across the entire magnet winding and the voltage drop across each individual coil. Perform measurements using regular and redundant voltage taps individually.
- 3.3.9.8 Perform complete RL&Q measurements per RHIC-MAG-R-7228.

4 Quality Assurance Provisions:

- 4.1 The Quality Assurance provisions of this procedure require that the technician shall be responsible for performing all assembly operations in compliance with the procedural instructions contained herein and the recording of the results on the production traveler.
- 4.2 The technician is responsible for notifying the technical supervisor and/or the cognizant engineer of any discrepancies occurring during the performance of this procedure. All discrepancies shall be identified and reported in accordance with RHIC- MAG-Q-1004.
- 4.3 Measuring and test equipment used for this procedure shall contain a valid calibration label in accordance with RHIC-MAG-Q-1000.

5 Preparation for Delivery:

- 5.1 N/A