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Large Hadron Collider
Magnet Division Procedure

Proc. No.: LHC-MAG-R-1037

Issue Date: June 2, 2003

Rev. No.: A

Rev. Date: June 2, 2003

Title: LHC D3 Electro-Mechanical Assembly

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REVISION RECORD

Rev. No.	Date	Page	Subject	Approval
A	6/2/03		Initial Release.	

1 Scope:

This specification describes the procedure for electro-mechanical assembly of the LHC D3 dipole magnet after the shells, endplates, and cradles 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-R-8554	RHIC Soldering Base Specification
RHIC-MAG-Q-1004	Discrepancy Reporting Procedure
14010488	D3 Dipole Cold Mass Assembly
14019011	D3 Dipole Wiring Diagram

3 Requirements:

3.1 Material/Equipment

12010004-WF-1	S-Bend Solder Fixture
12010004-WF-3	Solder Fixture, Crossover
12010004-TF-3	Tinning Fixture, Crossover Leads
12010004-WF4	Solder Fixture Flex Joint-Midplane Leads
E-53912	Ethyl Alcohol

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.

4 Assembly Procedure

NOTE

Check that the set screw torquing procedure has been completed at both ends

4.1 Crossover Joint - Post Leads

4.1.1 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

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

4.1.3 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.

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

4.2 Complete the Post Lead Crossover

4.2.1 Verify thickness of crossover. Thickness should be .195”-.220.”

NOTE

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

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

4.2.3 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

4.2.4 Remove excess flux using alcohol.

4.2.5 Repeat steps 4.2.2 – 4.2.4 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.

4.3 Left and Right Jumper Installation

4.3.1 Install the S-Bend (left jumper) 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 hard copper terminal.

4.3.2 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

4.3.3 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.

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

4.3.5 Repeat steps 4.3.1 – 4.3.4 for the right (straight) jumper solder splice.

4.3.6 Strip back 0.2" of insulation from end of the appropriate color voltage tap wire.

4.3.7 Locate the voltage tap wire on coil lead approximately 0.75 inches from the endplate and solder to the left coil midplane (S-bend jumper) splice as indicated.

NOTE

Ensure unused solder is recycled or disposed of properly

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4.3.8 Repeat steps 4.3.6 - 4.3.7 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.

4.3.9 Repeat steps 4.3.6 - 4.3.8 for the regular and redundant voltage taps at the right coil midplane (straight jumper) solder splice as indicated.

4.3.10 Remove excess flux using alcohol

4.4 Flex Joint Installation

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

4.4.2 Install the flex joint.

4.4.3 Install the flex joint-to-S-Bend (left jumper) 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.

4.4.4 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

4.4.5 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.

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

4.4.7 Repeat steps 4.4.3 – 4.4.6 for the flex joint-to-straight (right) jumper solder splice.

4.5 G-10 Insulator Installation

4.5.1 Wrap all the coil leads and splice joints with 2 layers of .002 in. kapton adhesive tape as shown on the assembly drawing.

4.5.2 Install the crossover insulators and insulator covers as shown on the assembly drawing.

4.5.3 Install the coil-to-flex joint insulators, insulator covers and mounting brackets as shown on the assembly drawing.

4.6 VT Resistor Mounting Board Installation

4.6.1 Assemble and install the resistor mounting board with their terminals and resistors.

4.6.2 Solder the six voltage tap wires to their assigned turrets as shown on the assembly drawing.

NOTE

Ensure unused solder is recycled or disposed of properly

4.6.3 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.

4.6.4 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 VT cable must be long enough to follow the curved shape of the flexible joint and exit out the "i" stub as shown.

4.7 Block (Warmup) Heater Installation

4.7.1 Prior to installation, perform resistance check of each block heater per Appendix A, section 8.

4.7.2 Install the two block heaters on the lead end plate. Wire them as indicated on the assembly drawing. Identify the leads as coming from left or right block heater.

NOTE

Left Right convention used is standing at the lead end looking towards the non-lead end.

4.8 Level Sensor Installation

4.8.1 Prior to installation, perform resistance check of each level sensor per Appendix A, section 10.

4.8.2 Install level sensor support bracket with stand-offs to the face of the lead end plate.

4.8.3 Attach the two level sensors to the bracket as indicated so that they curve to follow the path of the bracket. The leads are at the top. Secure the sensors with Kevlar lacing cord.

4.8.4 Label the level sensor leads as 'level sensor inner' and 'level sensor outer'. The inner sensor is the one closest to end plate.

4.9 Undulator Bus Installation

NOTE

This section applies to -01 Cold Mass Only

4.9.1 Feed this cable into the lower bus slot from the non-lead end, through the entire cold mass until it protrudes from the lead end. Then carefully route it under the main superconducting leads. Take special care to avoid chafing the insulation.

4.9.2 Make sure that the cable protrudes out each end by the proper amount, as indicated on the assembly drawing.

4.10 Instrumentation Wire Routing

4.10.1 Route all the instrumentation leads, except the voltage tap leads, to the flex joint 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, eight level sensor wires in two 4-wire harnesses , four block heater wires, and four quench strip heater wires.

4.10.2 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 (refer to the assembly drawing), and exits out the 1 inch diameter "i" stub located on the face of the lead end volume. The six VT leads (two 3-wire harnesses) are secured to this bundle approximately 12 inches from the 12 o'clock anchor point on the flex joint. The VT leads are not secured to the flex joint.

4.10.3 Make certain that all lacing cord knots have been coated with Scotchweld 2216 B/A Gray epoxy.

4.11 Post Assembly Electrical Checks

4.11.1 Perform electrical checks as noted in appendix 1.

5 Quality Assurance Provisions:

5.1 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.

5.2 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.

5.3 Measuring and test equipment used for this procedure shall contain a valid calibration label in accordance with RHIC-MAG-Q-1000.

6 Preparation for Delivery:

6.1 N/A

Appendix A -Post Assembly Electrical Tests

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. The leakage current must be less than 50 μa.

2. Connect Beam Tube, Coils & Iron to each other and to ground:

   - Perform 2.5kV Hypot between each connected pair of Quench Protection Resistors and ground per RHIC-MAG-R-7242. The leakage current must be less than 50 μA.

   - Perform 5kV Hypot between each connected pair of Quench Protection Resistors and ground per RHIC-MAG-R-7242. Record the leakage current.

3. 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. The leakage current must be less than 50 μA.

4. 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.

Resistance - Section 1 (lead → midplane) should be:	1.543-1.606Ω
Resistance - Section 2 (lead → lead) should be:	3.109-3.172Ω

5. Perform complete RL&Q measurements per RHIC-MAG-R-7228. Measured values should be:

R:	3.109-3.172 Ω
L:	27.19-28.30 mH
Q:	3.636-4.444

6. Perform resistance check between normal and redundant voltage tap wire at each point. Resistance to be 320Ω - 480Ω.

7. Perform resistance check of each connected pair of quench protection resistors. The acceptable range is 2.8Ω-3.4Ω.

8. Perform resistance check of each warm-up heater. The acceptable range is 95Ω-105Ω.

9. Perform resistance check of each yoke temperature sensor as noted in LHC-MAG-R-1051.

10. Perform resistance check of each liquid helium level sensor as noted in LHC-MAG-R-1051.