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Large Hadron Collider
Magnet Division Specification

Proc. No.: LHC-MAG-R-1004

Issue Date: July 1, 1999

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Class: Magnet Assembly
Title: LHC 8cm D2/D4 2.95M and 10M Dipole Collaring

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ES&H Review: Signature on File

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1. Scope:

This procedure describes the methods used to prepare a LHC 8cm Dipole Collared Coil Assembly.

2. Applicable Documents:

RHIC-MAG-R-7228 RHIC Inductance and Q Measurement
RHIC-MAG-R-7242 RHIC Hypot Testing
RHIC-MAG-R-7243 RHIC Low Precision Resistance Insulation Test
RHIC-MAG-R-7318 RHIC Impulse Testing
RHIC-MAG-R-7261 RHIC Beam Tube Assembly Hypot Testing
RHIC-MAG-R-7320 RHIC Electrical Resistance Measurement for Collared Individual
Coils and Connected Coil Sets
RHIC-MAG-Q-1004 Discrepancy Reporting Procedure
RHIC-OPM 8.1.1.5 Operation of Collaring Press

BNL Dwg. No. 14010002 LHC Prototype Dipole Collared Coil Assembly
BNL Dwg. No. 14010135 LHC D2/D4 Collared Coil Assembly
BNL Dwg. No. 14010553 LHC D4 Collared Coil Assembly

3. Requirements:

3.1 Material/Equipment:

3.2 Safety Precautions:

3.2.1 Operators shall be qualified by their cognizant technical supervisor in the safe operation of the collaring press in accordance with RHIC-OPM 8.1.1.5.

3.2.2 Due to the use of hydraulic fluid under high pressure, all technicians must use safety glasses during the collaring operations. The assembly area near the collaring press must have restricted access while the press is in operation.

3.2.3.1 The technicians shall be qualified by their cognizant technical supervisor in the operation of the required electrical test equipment and the electrical testing procedures. They shall be familiar with the latest revision of the applicable

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documents referenced in Section 2. In addition, some of these tests require the technician to have special training. A list of qualified personnel shall be maintained with the Training Coordinator.

- 3.2.4 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.
- 3.2.5 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.
- 3.2.6 All lifting and handling operations requiring overhead crane operations shall be performed by holders of valid Safety Awareness Certificates. They shall also be trained and certified in the use of the appropriate lifting devices by the Cognizant Engineer or Technical Supervisor.
- 3.3 Procedure:
 - 3.3.1 Record the cold mass I.D., the two coil serial numbers, and their respective locations in the traveler.
 - 3.3.2 Coil Preparation
 - 3.3.2.1 Remove the upper coil from the transporter box, and position it, midplane up, on the lower roller supports.
 - 3.3.2.2 Install the upper roller supports and rotate the coil 180 degrees.
 - 3.3.2.3 Remove the lower coil supports, lift the coil from the rollers and temporarily place it on a table, midplane down.
 - 3.3.2.4 Remove the lower coil from the transporter box, and position it, midplane up, on the lower roller supports.

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- 3.3.2.5 Place the insulated beam tube in the I.D. of the lower coil as shown on the assembly drawing. Verify correct orientation based on the drawing and the version of the collared coil assembly being fabricated.
- 3.3.2.6 Move the upper coil into position on top of the lower coil. Align the two coils at the rear face of the lead end polespacer within .03 in.

NOTE: Applying the coil insulation will require rotating the coil and removing the roller supports at various stages of the assembly.

- 3.3.2.7 Apply the teflon tape to the O.D. of both coils as shown on the collared coil assembly drawing. Trim the tape at the pole and midplane surfaces.
- 3.3.2.8 Apply strips of teflon tape at the ends of the coil in the area of the pole to achieve the same radial build up in this area as on the coil O.D.
- 3.3.2.9 Install the four quench protection resistor assemblies as shown on the collared coil assembly drawing.
- 3.3.2.10 Apply two layers of kapton tape to the ends of the coil in the area of the pole to achieve the same radial build up in this area as in the area covered by the quench protection resistors.
- 3.3.2.11 Apply the first layer of creased caps (“J”). Trim the caps so that they end at the first notch on the end polespacers. (.25 inches into the polespacers)
- 3.3.2.12 Apply .001” x 1/2” wide kapton tape to the circumferential joints at the ends of the kapton caps.
- 3.3.2.13 Apply the second layer of creased caps (“L”). Trim the caps so that they end at the beginning of the end polespacers.
- 3.3.2.14 Apply kapton tape .001” x 1/2” wide to the circumferential joints at the ends of the kapton caps.
- 3.3.2.15 Spiral wrap the NL end of the coils with 2 layers of 50% overlap Kapton tape as shown on the collared coil assembly drawing.
- 3.3.2.16 Apply Kapton tape to the I.D. of the LE brass spacers as shown on the collared coil assembly drawing.

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3.3.2.17 Install the LE brass spacers as shown on the collard coil assembly drawing.

3.3.3 Collar Pack Installation

3.3.3.1 Perform pre-assembly collar pack inspections per data sheet #1. Collars inspected without coils, with production keys installed and collars drawn away from each other to remove any key/keyway clearance.

3.3.3.2 Starting at the lead end, install the collar packs. Temporarily hold all top and bottom collar module assemblies together using velcro straps or suitable clips in the tapered keyways of the collars. Install strain gauge collar packs in the 2.95m prototype magnets as shown on the assembly drawing.

3.3.3.3 Using a heavy magic marker, mark the split lines (separation point between the press sections) on the lower laminations. The location of the split lines is shown on the collared coil assembly drawing.

3.3.3.4 Install assembly into collaring press and remove all temporary supports.

3.3.4 Pre-Assembly Electrical Tests:

CAUTION: Be sure the "Hypot", beam tube and collar assembly are grounded at all times. Failure to observe this caution may result in electrocution.

3.3.4.1 Perform a coil-to-coil hypot check at 3 kV, following RHIC-MAG-R-7242.

NOTE: The leakage current must be less than 50 μ a.

3.3.4.2 Electrically connect all the main coil leads together.

3.3.4.3 Perform a hypot check between the main coils and the collars at 5 KV, attaching the grounded lead of the hypot tester to the collars following RHIC-MAG-R-7242.

NOTE: The leakage current must be less than 50 μ a.

3.3.4.4 Perform a hypot check between the collars and each of the quench protection resistors at 2.5kV, attaching the grounded lead of the hypot tester to the collars following RHIC-MAG-R-7242.

NOTE: The leakage current must be less than 50 μ a.

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- 3.3.5 Collar Pressing and Keying
 - 3.3.5.1 Reconnect the coils in series per RHIC-MAG-R-7320 and supply one (1)amp DC. Monitor the DVM's throughout the collaring operation to detect any turn-to-turn electrical shorts.
 - 3.3.5.2 Apply lubricant to all the keys per the collared coil assembly drawing.
 - 3.3.5.3 Position the magnet so that press section #1 is in the collaring press.
 - 3.3.5.4 Lower the upper platten so that the weight of the platten is on the collared coil assembly.
 - 3.3.5.5 Install the first set of keys into the key holder cassettes.
 - 3.3.5.6 Apply a vertical load in steps of 100 psig until the LVDT readings indicate that the keyway opening = .217 in. Store the applied load and LVDT data in the computer at each step. For the 2.95m prototype magnets, record the strain gauge data at each step.
 - 3.3.5.7 Apply side load to the keys in increments of 250 psig and decrease the vertical load in increments of 100 psig after each increase in side load. When the keys are fully seated, remove all side pressure followed by any remaining vertical load.
 - 3.3.5.8 Repeat steps 3.3.5.3 - 3.3.5.7 for the remaining press sections. See the table below for the length of each press section and the number of cylinders used:

Magnet	Press Section	Section Length	No. Cylinders Active
2.95m Prototype	#1 (LE)	83.54	16
2.95m Prototype	#2 (NL)	40.12	8
10m D2/D4	#1 (LE)	83.37	16
10m D2/D4	#2 - #4	72.00	14
10m D2/D4	#5	60.00	12
10m D2/D4	#6 (NL)	19.52	4

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NOTE: Due to the coil ends being softer than the straight section of the coils, the end yokes may close sooner than the center yokes. If so, the end hydraulic cylinders are to be valved off when keys can be inserted in the end collar laminations and the pressure at which the cylinders were valved off is to be noted in the traveler.

3.3.6 Post-Assembly Electrical Tests:

3.3.6.1 With coils unconnected, measure coil temperature. Measure voltage drops across coils at 1 amp DC, following RHIC-MAG-R-7320. Complete the measurements of inductance and quality factor (Q) following RHIC-MAG-R-7228.

3.3.6.2 Perform an ohmmeter check of the resistance between the two coils, following RHIC-MAG-R-7243. Verify that the resistance is at least 20 megohms.

CAUTION: Be sure the "Hypot", beam tube and collars are grounded at all times. Failure to observe this caution may result in electrocution.

3.3.6.3 Perform a coil-to-coil hypot check at 3 kV, following RHIC-MAG-R-7242.

NOTE: The leakage current must be less than 50 μ a.

3.3.6.4 Electrically connect the main coil leads together.

3.3.6.5 Perform a hypot check between the main coils and the collars at 5 kV, attaching the grounded lead of the hypot tester to the collars following RHIC-MAG-R-7242.

NOTE: The leakage current must be less than 50 μ a.

CAUTION: Be sure the "Impulse Tester", collars, and beam tube are grounded at all times. Failure to observe this caution may result in electrocution.

3.3.6.6 Disconnect the coils from each other and perform an impulse test of the individual coils at 2 KV, following RHIC-MAG-R-7318.

3.3.6.7 Reconnect the coils in series as per RHIC-MAG-R-7320.

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- 3.3.6.8 Perform an impulse test of the series connected coils at 2 KV, following RHIC-MAG-R-7318.
- 3.3.6.9 Disconnect the coils from each other and measure coil temperature. Measure voltage drops across each coil at 1 amp DC, following RHIC-MAG-R-7320. Complete the measurements of inductance and quality factor (Q) following RHIC-MAG-R-7228.
- 3.3.6.10 Perform a hypot check between the collars and each of the quench protection resistors at 2.5 KV, attaching the grounded lead of the hypot tester to the collars following RHIC-MAG-R-7242.
- 3.3.6.11 Cognizant electrical engineer to review test data and sign-off traveler "OK to Proceed".

3.3.7 Final Mechanical Assembly:

CAUTION: Hard hats are required when overhead crane is in use. Failure to observe the caution may result in head injury.

- 3.3.7.1 Clearly and boldly mark the face on the last lead end lamination with the cold mass serial number, part number, and revision. Also indicate with an arrow which side is "UP". Use a heavy permanent marker.
- 3.3.7.2 Use overhead crane to move the collared coil assembly to roller supports. Support the cold mass at no less than every three feet along its length.
- 3.3.7.3 If this is the first collared assembly, measure the length of the upper coils following RHIC-MAG-R-7226 and record the lengths in the traveler.
- 3.3.7.4 Check for laminations that protrude radially outward beyond the rest. This is an indication of a defective collar lamination. No lamination shall protrude more than .010 in. above the rest.
- 3.3.7.5 Perform post assembly collar inspection per data sheet #1.
- 3.3.7.6 Attach the coil end pressure plates.

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4. Quality Assurance Provisions:

- 4.1 Insure all inspection and test operations have been verified and signed on the Production Traveler by the cognizant operator and that any discrepancies have been reported as per RHIC-MAG-Q-1004.

5. Preparation for Delivery:

N/A

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Data Sheet #1
Collar Inspection

Pre-Assembly

	Vertical OD	Horizontal OD
Straight Section Pack		
Lead End Pack		
Non-Lead Pack		

Post Assembly

Distance From LE (in.)	Vertical O.D.	Horizontal O.D.	Distance From LE (in.)	Vertical O.D.	Horizontal O.D.
3			200		
9			220		
20			240		
40			260		
60			280		
80			300		
100			320		
120			340		
140			360		
160			371		
180			377		