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SMD
Magnet Division Procedure

Proc. No.: LHC-MAG-R-1059

Issue Date: January 13, 2004

Rev. No.: C

Rev. Date: November 21, 2005

Title: LHC D3 Dipole Magnet – Insertion of Cold Mass into Cryostat

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REVISION RECORD

Rev. No.	Date	Page	Subject	Approval
A	1/13/04		Initial Release	
B	2/18/04		Changes per ECN MG#2169	
C	11/21/05		Changes per ECN MG#2175	

1 Scope:

This specification establishes the procedure for LHC D3 insertion of the twin dipoles into the cryostat.

2 Applicable Documents:

The following documents, in effect on the date of issue of this specification, form a part of this specification:

RHIC-MAG-M-7422	CQS Multi-Layer Insulation Fabrication
RHIC-MAG-R-7423	Multilayer Insulation Installation
RHIC-MAG-Q-1000	Control of Measurement Test Equipment
RHIC-MAG-Q-1004	Discrepancy Reporting Procedure
LHC-MAG-R-1045	LHC LWR Heat Shield Pressure & Leak Check Proc.
14060277	D3 Lower Thermal Shield Weldment Assembly
14010508	D3 Combined Cold Mass Assembly
14060323	D3 Cryostatted Magnet Assembly

3 Requirements:

3.1 Material/Equipment

Lifting Beam	BNL Dwg. 25-1782.02-5
Insertion Fixture	BNL Dwg. 25-1819.01-5
Pipe Alignment Fixture	BNL Dwg. 25-1910.01-5

3.2 Safety Precautions

3.2.1 No welding shall take place unless all welding screens are in place around the welding station, and all personnel not directly involved with the welding process are outside the screens. Any personnel inside the screens shall wear protective gear to prevent eye injury, and shall be clothed to prevent burns caused by intense ultra-violet light.

3.2.2 Operators shall be instructed by their cognizant technical supervisor and qualified in the operation of the required welding equipment.

3.2.3 All lifting and handling operations requiring overhead crane operations shall be performed by holders of valid Safety Awareness Certificates. They shall also be instructed in the use of the appropriate lifting device by the Cognizant Engineer or Technical Supervisor.

3.2.4 Operators shall be instructed by their Cognizant Technical Supervisor in the operation of the Insertion Fixture.

3.2.5 Specific steps of this procedure contain electrical and mechanical assembly operations that impact the environment. Prior to performing these steps, personnel shall complete the applicable facility specific environmental training.

4 Procedure

4.1 Transfer Line CL/LD Position Adjustment at Ends

4.1.1 Configure the pipe alignment fixture (25-1910.01) for CL/LD position adjustment at the lead end.

4.1.2 At the lead end, adjust the CL/LD support bracket and tighten the (3) screws to lock the CL/LD lines in their proper position.

4.1.3 Configure the pipe alignment fixture for CL/LD position adjustment at the non-lead end. Note that CL/LD is positioned lower relative to the lead end.

4.1.4 At the non-lead end, adjust the CL/LD support bracket and tighten the screws to lock the CL/LD line (-01 side only) in its proper position

4.2 Heat Shield Return Line (e2) Installation

4.2.1 At the lead end, slide the e2 (return) tube through the large opening on the right side of the lower heat shield. This tube lays on the bottom of the opening and runs the full length of the heat shield.

4.2.2 At the lead end, slip the aluminum retainer over the vertical section of tube. Locate the line in its proper position in all axes per the heat shield assembly drawing (14060277) and TIG weld the retainer to the heat shield using aluminum welding rod 12060094.

4.2.3 Reconfigure the alignment fixture (25-1910.01), for positioning the heat shield supply and return lines e1and e2 at the NLE.

4.2.4 At the non-lead end, using the alignment fixture, locate the e2 line at its proper position and TIG weld the aluminum cap to the heat shield using aluminum welding rod 12060094.

4.3 Heat Shield Supply Line (e1) Installation.

4.3.1 Install the alignment fixture at the non-lead end of the magnet. Temporarily secure the aluminum cap in its proper position on the left heat shield (supply) orifice with adhesive tape. Place witness marks on cap and heat shield to help realign later.

4.3.2 Using the fixture as a guide, transfer punch the hole center onto the aluminum cap.

4.3.3 Drill the thru-hole in the cap using the transfer punch dimple as its center. Re-apply cap to heat shield, aligning witness marks. Install bi-metallic transition at proper depth on cap using fixture, and tack weld to cap. Remove cap.

4.3.4 Weld the aluminum end of the bimetallic transition piece to the aluminum cap as indicated on the assembly drawing using ER5356 weld rod (14060348) to weld it to the heat shield. Leave extra stainless tubing length available at the outer end since it will be cut to final length in preparation for shipping. Use an argon purge if affixing an extension pipe to the bimetallic transition piece

4.3.5 Fixture the cap with welded transition piece against the heat shield and rotate it into its proper position. Tack weld the cap into place. Then remove the fixture.

4.3.6 Weld the cap into place using aluminum welding rod 12060094.

4.3.7 At the Lead End, drill thru hole for vertical e1 stub in accordance with heat shield assembly drawing (14060277). Clean chips with vacuum.

4.3.8 Tack weld bimetallic transition in place at LE. Then weld it with ER5356 weld rod (14060348). Leave extra stainless tubing length available at the end since it will be cut to final length in preparation for shipping. Use argon purge if affixing an extension pipe to the bimetallic transition piece.

4.3.9 Weld the indicated conflat test flange on the stainless end of the e1 stubs (both ends).

4.4 Vacuum Vessel Preparation

4.4.1 Brush and vacuum the interior of the vacuum vessel, if required. Make sure that the threads in the leg surfaces are clean.

4.4.2 Check the vacuum vessel leg sealing surfaces for any damage (radial scratches, nicks, etc.).

4.4.3 Align the vacuum vessel on the insertion fixture using the pins and spherical bearings.

4.4.4 Place the movable cryostat support under the non-lead end of the cryostat.

4.4.5 Install three full dog-point set screws on each of the six Taylor-Hobson fiducial cups (14060209) so that the point extends 2mm (.079 in.) beyond the bottom. Install the cups and torque the locking screws to 8-10 ft-lbs.

4.4.6 Fill the rings around each Taylor-Hobson fiducial cup with Stycast 2850 epoxy to a depth of 3-4mm (.12-.16 in.).

4.4.7 Fill the hex socket in both locking screw heads on each Taylor-Hobson fiducial cup with Stycast 2850 epoxy.

4.5 Final Cold Mass Build Up

NOTE

Prior to beginning work, perform a test of each Emergency Stop button on the insertion fixture. Record results of the test in the traveler.

4.5.1 Mount the flexible heat station clamp to each of the IFS lines. Torque all screws to 18 in-lb.

4.5.2 Trim the warm head tube on each of the IFS lines to 2.25” from bottom of base..

4.5.3 Insulate the IFS lines as indicated on the assembly drawing.

4.5.4 Interleave and ultrasonic weld approximately every six layers of the cold mass blanket. Spacer material (12060093-17) must be used on top of the outer layer of aluminized mylar to reinforce welds. Use stainless backing strip when welding.

4.5.5 Interleave and ultrasonic weld approximately every six layers of the inner pipe

blanket. Spacer material (12060093-17) must be used on top of the outer layer of aluminized mylar to reinforce welds. Use stainless backing strip when welding.

4.5.6 Interleave and ultrasonic weld approximately every six layers of the outer pipe blanket. Use stainless backing strip when welding.

4.5.7 Install the end volume blankets and secure with mylar tape and lacing cord. Secure all lacing cord knots with Scotchweld 2216 gray epoxy.

4.5.8 Install the upper heat shield on top of the lower, making sure that the upper heat shield is even on both ends with the lower heat shield.

NOTE

Care should be taken to protect lower thermal shield weldment from accidental contact during rigging

4.5.9 Install the free ends of the IFS heat stations on the upper heat shield. Torque all screws to 8 in-lb.

4.5.10 Weld both sides of the upper heat shield to the lower heat shield using aluminum welding rod 12060094. Allow to cool. Make sure weld screen is in place during welding operation to avoid injury.

4.5.11 Interleave and ultrasonic weld approximately every ten layers of the inner heat shield blanket. Spacer material (12060093-17) must be used on top of the outer layer of aluminized mylar to reinforce welds. Use stainless backing strip when welding.

4.5.12 Interleave and ultrasonic weld approximately every ten layers of the outer heat shield blanket. Use a stainless steel backing strip when welding.

4.5.13 Wrap a temporary .010 in. thick mylar shield around the outside of the insulation blankets and tape into position at the end volumes.

4.6 Spacer Shim Preparation

4.6.1 Mark the post spacer plates, LE, CTR, NLE. Measure thickness of each in four places, 90 degrees apart, to the nearest .001 in. Record readings in traveler and calculate average for each plate.

4.6.2 Mark the retaining rings, LE, CTR, NLE. Measure thickness of each in four places, 90 degrees apart, to the nearest .001 in. Record readings in traveler and calculate average for each ring.

4.6.3 Record the three average post heights, LE, CTR, and NLE, under load from the data sheet in the last procedure, LHC-MAG-R-1040.

4.6.4 Post shim thicknesses shall be selected so that the center post assembly is .84mm (.033 in.) higher than the two outer post assemblies. Nominal shim size for outer posts is 23.0 mm (0.906 in.). Nominal shim size for center post is 23.8 mm (0.939 in.). However, actual shim thickness shall be adjusted so that:

- The height between the centerline of the cold mass and the bottom of the retaining ring at each end is 580.0 mm (22.835 in.).

- The height between the centerline of the cold mass and the bottom of the retaining ring at the center is 580.8 mm (22.868 in.).

Machine the LE, CTR, NLE shims to the required thickness and mark each. Record the shim thickness data in the traveler.

4.7 Cold Mass Installation

4.7.1 Position the movable bridge/tray assembly. Tighten all bolts between sections to form a continuous structure.

4.7.2 Slide the cryostat trays into position. One tray slides into the cryostat from each end.

4.7.3 Install the tray alignment bushings in the cryostat legs.

4.7.4 Attach the pull chain to the sled assembly.

CAUTION

All non-essential personnel shall stand clear of the hydraulic assembly and hoisting chain while the cold mass is being pulled. Be aware of potential equipment failure and chain snap back.

4.7.5 Pull the cold mass assembly into the vacuum vessel. Align the center post on the cold mass with the center hole in the vacuum vessel.

NOTE

Watch for interference during pull-in.

4.7.6 Install the spacer plate, machined shim and snap ring over the center lifting mechanism.

4.7.7 Install the center lifting post so that it engages in the hole in the base of the center cold mass cradle.

4.7.8 Mount the lifting plates to the end volumes at each end and tighten all bolts.

CAUTION

Operating in JOG Mode Only

4.7.9 Using the appropriate buttons on the Duff-Norton control panel, individually activate each lifting mechanism to take up any slack in the system.

4.7.10 Using the Duff-Norton panel, lift the cold mass by simultaneously activating the lift mechanisms for the center and both the ends.

NOTE

Prior to magnet movement, operator and spotters should be aware of the location of the nearest Emergency Stop button on the fixture

4.7.11 Remove the insertion sleds.

4.7.12 Remove the insertion tray alignment bushings and the insertion trays.

4.7.13 Only if necessary, lower the magnets to gain additional clearance to snake IFS warm heads into position. Then raise the magnet back up.

4.7.14 Install spacer plates, machined shims and retaining rings in each cryostat leg.

4.7.15 Using the Duff-Norton screw jack, lower cold mass and remove lifting tooling.

NOTE

Prior to magnet movement, operator and spotters should be aware of the location of the nearest Emergency Stop button on the fixture

4.7.16 Install IFS warm heads into ports in cryostat and manually TIG weld.

4.7.17 Slide out the mylar sheet that was temporarily installed over outer blanket.

4.7.18 Loosen end cradle shipping restraint straps (4 places) by backing off nut until it contacts the retaining ring.

4.8 Vacuum Vessel Sag Measurement

4.8.1 Using 14 slings and Lifting Beam 25-1782.02 as shown below, move the cryostatted magnet assembly to the precision support stands, supporting the cryostat at the two outer leg castings. Center leg is unsupported.

CAUTION

Use of the Lifting Beam (BNL Dwg. 25-1782.02) is permitted to lift the D3 Magnet Assembly only if the load is equally distributed on 14 of 17 lifting lugs (center lug and lugs 3 from each end are not used). See the Figure 1 below:

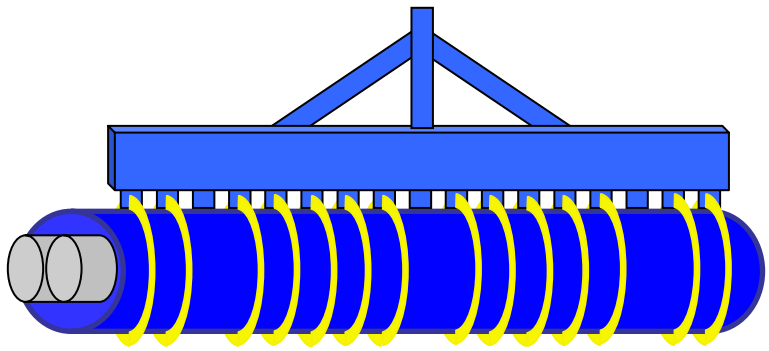

Figure 1 - D3 Magnet Assembly Rigging

4.8.2 For each leg, measure height from table to bottom of retaining ring at four locations 90^0 apart. Enter data into the traveler and calculate the average for each leg.

4.8.3 Select the averages for the LE & NLE legs. Average them together and subtract the average for the middle leg. Record this in the traveler. The resultant shall be 0.84 mm +1.25/-.000 (0.033 in.+0.050 /-.000). Values out of range shall be brought to the attention of the Cognizant Engineer.

4.9 Heat Shield Pressure Leak Test While In Cryostat

CAUTION

Install shielding on /over flanges during pressure testing. Install barriers. Eye protection shall be worn during testing.

NOTE

Pressure test shall be witnessed by the ES&H Coordinator or Safety Engineering.

4.9.1 Pressure test assembly to 400 PSIG (pneumatic) per LHC-MAG-R-1045. After pressure test, perform leak check /LHC-MAG-R-1045. Max leak rate 2 x 10^{-10} Std. cc He /Sec.

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:

N/A