BROOKHAVEN NATIONAL LABORATORY
Superconducting Magnet Division

LHC D1 MAGNET ASSEMBLY
BAY 'E' WARM & COLD TESTING
PRODUCTION TRAVELER

MDC No. 744 Rev. B
Sheet 1 of 17
Issued: 3/18/02

Cognizant Engineer: _____

Electrical Engineer: _____

LHC Project Engineer: _____

Magnet Test Group: _____

Quality Assurance: C. Ponett 3/19/02

Reference Documents:
RHIC-MAG-Q-1004 Rev. C

SERIAL NO.	Deviation & Waiver #:
D1L_____	

OP	AREA	OPERATION DESCRIPTION	REFERENCE PROCEDURE	NAME /LIFE #	DATE	DR No.
10	902	*Cognizant Electrical Engineer to determine need for additional electrical checks prior to Testing. If additional testing is required, obtain copy of traveler 749 from MDC for insertion into traveler book. That work is to be performed prior to this traveler.* *Cognizant Engineer to initial:* Required: ____ NOT Required: ____				
20	902	Install lead and spool piece to magnet. Install magnet on alignment pins in bay. Perform portable end can mechanical connections.				
30	902	Perform Lead End electrical preparations				
40	902	Complete lead can electrical connections.				
50	902	Temporarily close lead end can connections (upper & lower).				

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		Caution: During all Hypot operations in this section, ensure that the leads for the Temperature Sensors are floating and not connected to ground.				
60	902	Connect Beam Tube, Quench Protection Resistors & Iron to each other and to ground. Connect coils to each other and perform 1.5 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. Leakage: _____ µa.				
70	902	Connect Beam Tube, Coils & Iron to each other and to ground. Perform 1.5Kv 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. Circuit 1: _____ µa. Circuit 2: _____ µa.				
80	902	Connect Beam Tube, Coils, Iron & Quench Protection Resistors to each other and to ground. Perform 1.5Kv Hypot between each warm-up heater circuit and ground per RHIC-MAG-R-7242. The leakage current must be less than 50 µa. Circuit 1: _____ µa. Circuit 2: _____ µa.				
90	902	Perform Quench Protection Resistance test on each connected pair of resistors.				
				Ω		
		Circuit 1				
		Circuit 2				

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100	902	Perform Warm Up Heater Resistance test on each connected pair of heaters.					
				Ω			
		Circuit 1					
		Circuit 2					
110	902	Perform DC resistance checks per RHIC-MAG-R-7320 to measure voltage drops @ 1.0 amp DC. Complete measurements of RLQ per RHIC-MAG-R-7228.					
		MVT Pin #	**Voltage**				
		+					
		1					
		2					
		3					
		4					
		5					
		6					
		7					
		8					
		9					
		10					
		11					
		12					
		13					
		14					
		-					
		Temp:					
		L					
		Q					

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<table>
<tr><td rowspan="16">120</td><td rowspan="16">902</td><td colspan="3">Perform resistance check of all tap circuits and record below.</td><td rowspan="16"></td><td rowspan="16"></td><td rowspan="16"></td><td rowspan="16"></td></tr>
<tr><td>From</td><td>To MVT Pin #</td><td>Ω</td></tr>
<tr><td rowspan="14">+ Lead
↓</td><td>1</td><td></td></tr>
<tr><td>2</td><td></td></tr>
<tr><td>3</td><td></td></tr>
<tr><td>4</td><td></td></tr>
<tr><td>5</td><td></td></tr>
<tr><td>6</td><td></td></tr>
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<tr><td>13</td><td></td></tr>
<tr><td>14</td><td></td></tr>
</table>

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<table>
<tr><td>130</td><td>902</td><td>Perform resistance check of yoke temperature sensors.
To avoid possible damage to the probe, do not exceed manufacturers voltage & current limits while testing
Sensor 1
<table><tr><th>FT5 Pins</th><th>Ω</th></tr><tr><td>5-6</td><td></td></tr><tr><td>7-8</td><td></td></tr><tr><td>5-7</td><td></td></tr><tr><td>6-8</td><td></td></tr><tr><td>4 - Wire</td><td></td></tr></table>
Sensor 2
<table><tr><th>FT5 Pins</th><th>Ω</th></tr><tr><td>9-10</td><td></td></tr><tr><td>11-12</td><td></td></tr><tr><td>9-11</td><td></td></tr><tr><td>10-12</td><td></td></tr><tr><td>4 - Wire</td><td></td></tr></table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>140</td><td>902</td><td>Perform resistance test of Yoke temperature sensor /lead wire combination → ground.
To avoid possible damage to the probe, do not exceed manufacturers voltage & current limits while testing.

Sensor 1: _____

Sensor 2: _____</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>150</td><td>902</td><td>Cognizant Electrical Engineer to review test data and sign-off traveler:

"Ok to Proceed": _____</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>160</td><td>902</td><td>Notify Control Room that electrical checks are done.</td><td></td><td></td><td></td><td></td></tr>
</table>

170	902	Seal cryogenic lines. Complete portable end can and spool piece installation. Install stainless steel 1/2" vacuum line (to heat exchanger). Complete lead can internal mechanical connections.				
180	902	Vacuum leak check heat exchanger vacuum line.				
190	902	Cold Mass pressure leak check				
200	902	Insulate NLE & LE end-volume. Insulate and close non-lead end vacuum vessel. Install warm bore tube. Insulate and close lead end vacuum vessel.				
210	902	Pump down vacuum vessel. External vacuum leak check.				
220	902	Mechanical & Cryogenic Lead Men to notify Control Room				
230	902	Control Room to perform warm electrical checks prior to cool down. Record data in table 3.				
240	902	If required, complete warm harmonic measurements on cryostatted cold mass in MAGCOOL test bay. If testing is required, go to Table 5. Required (✓): ____ Not Required (✓): ____ ***Magnet Test Supervisor to initial for bypass:*** **_____**				

250	902	Pump and purge procedure. Cold mass to vacuum vessel leak check.				
260	902	Activate lead heaters. Check water flow.				
270	902	Notify Cryogenics to start cool-down.				
280	902	Start Cool-Down.				
290	902	Verify operation of lead heaters & water flow by cryogenics operator.				
300	902	Cryogenics operator to notify control room and vacuum group when magnet is $\leq 6^0$ K.				
310	902	Cold leak check complete. CHECK (✓) PASS ___ FAIL ___				
320	902	When T $\leq 6^0$ K & Pressure $>$ 5 Atmosphere, control room to perform cold electrical checks. Record data in table 4.				
330	902	Verification by Cryogenic Lead Man: Magnet prepared, cold, and ready for test.				
340	902	Balance out Quench detectors when required. CHECK (✓) YES ___ NO ___				
350	902	Completion of 1000 amp Shutoff Test. Run No. _____				

360	902	Strip heater shutoffs: 2000A: _____ 3000A: _____ 4000A: _____ 5000A: _____ 6000A: _____				
370	902	Complete 5500 5m Flat Top Quench Run				
380	902	Complete Quench tests (20 A/s, one hour minimum recovery)				
390	902	Perform required tests as noted in Table 6 "Optional Cold Test Runs" Required (✓): ____ Not Required (✓): ____ ***Magnet Test Supervisor to initial for bypass: _____***				
400	902	Notify Cryogenics to start warm-up.				
410	902	Magnet warm-up complete. Vent vacuum system with N_2.				
420	902	Open lead end of vacuum vessel. Remove insulation blankets.				
430	902	Remove warm bore tube.				

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440	902	Disconnect and inspect lead can mechanical connections.				
450	902	Disconnect and inspect lead can electrical connections.				
460	902	Disconnect and inspect end can mechanical connections.				
470	902	Disconnect and remove heat exchanger vacuum line.				
480	902	Authorized approval of operations: Control Room: _____ Cryogenics: _____ Electro / Mechanical: _____ Mechanical Support: _____				
490	902	Verify all traveler operations complete				
998		**Traveler Comments:** _____ _____				
999		**Revision History:** Rev A: Initial Release 11/9/01 Rev B: Traveler rewritten /new requirements 3/12/02.				

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Table 3 - Warm Electrical Checks - Resistance Checks

Test	Resistance (Ω)
Magnet Coil ⇒ Ground	
Magnet Coil: + ⇒ -	
Magnet Coil ⇒ Strip Heater	
Magnet Coil ⇒ Ground + Strip Heaters #1 & #2	
Magnet Coil ⇒ Ground + Warm Up Heaters #1 & #2	
Strip Heater #1 ⇒ Ground	
Strip Heater #2 ⇒ Ground	
Strip Heater #1: + ⇒ -	
Strip Heater #2: + ⇒ -	
Warmup Heater ⇒ Ground *IF REQUIRED*	
Warmup Heater #1: + ⇒ - *IF REQUIRED*	
Warmup Heater #2: + ⇒ - *IF REQUIRED*	
W1-W2	
W1-L1	
W1-L4	
W1-L5	
W1-A	
W1-B	
W1-C	
W1-L6	
W1-W4	
W1-W3	
W2-L1	
L1-A	
A-B	
B-C	
C-L6	
L6-W4	
W4-W3	

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Table 3 - Warm Electrical Checks - Voltage Drops @ 1 Amp DC Prior to Cool down

Test	Voltage	Location
Main Magnet Coil: + ⇒ -		
W1-W2		@ Bay Box
W1-L1		
W1-L4		
W1-L5		
W1-A		
W1-B		
W1-C		
W1-L6		
W1-W4		
W1-W3		

W2-L1		@ Bay Box
L1-A		
A-B		
B-C		
C-L6		
L6-W4		
W4-W3		

A-B /100		In Horizontal Control Room
B-C /100		
AB-BC x .5		
A-C /200		
Warm 1 Amp DC level shift (✓) YES ___ NO ___ File Name: _____		Optional

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Table 4 - Cold Electrical Checks - Resistance Checks

Test	Resistance (Ω)
Magnet Coil ⇒ Ground	
Magnet Coil: + ⇒ -	
Magnet Coil ⇒ Strip Heater	
Magnet Coil ⇒ Ground + Strip Heaters #1 & #2	
Magnet Coil ⇒ Ground + Warm Up Heaters #1 & #2	
Strip Heater #1 ⇒ Ground	
Strip Heater #2 ⇒ Ground	
Strip Heater #1: + ⇒ -	
Strip Heater #2: + ⇒ -	
Warmup Heater ⇒ Ground *IF REQUIRED*	
Warmup Heater #1: + ⇒ - *IF REQUIRED*	
Warmup Heater #2: + ⇒ - *IF REQUIRED*	
W1-W2	
W1-L1	
W1-L4	
W1-L5	
W1-A	
W1-B	
W1-C	
W1-L6	
W1-W4	
W1-W3	
W2-L1	
L1-A	
A-B	
B-C	
C-L6	
L6-W4	
W4-W3	

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Table 4 - Cold Electrical Checks - Voltage Drops @ 1 Amp AC

Test	Voltage	Location
Main Magnet Coil: + ⇒ -		
W1-W2		@ Bay Box
W1-L1		
W1-L4		
W1-L5		
W1-A		
W1-B		
W1-C		
W1-L6		
W1-W4		
W1-W3		

W2-L1		@ Bay Box
L1-A		
A-B		
B-C		
C-L6		
L6-W4		
W4-W3		

A-B /100		In Horizontal Control Room
B-C /100		
AB-BC x .5		
A-C /200		

Table 5 - WARM

1. Indicate point at which warm harmonic measurements were performed.

   Required: ____ Not Required: ____

   Prior to cold testing: ____ After completion of cold testing: ____

2. Complete warm integral field measurements. Required: ____ Not Required: ____

   Record Run No. _____

3. Complete warm Z-Scan, attach summary sheets, transfer data. Required: ____ Not Required: ____

   Record Run No. _____

   Position #1, Z=0.00 (✓): __
   Position #2, Z=39.37 (✓): __
   Position #3, Z=78.74 (✓): __
   Position #4, Z=118.11 (✓): __
   Position #5, Z=157.48 (✓): __
   Position #6, Z=196.85 (✓): __
   Position #7, Z=236.22 (✓): __
   Position #8, Z=275.59 (✓): __
   Position #9, Z=314.96 (✓): __
   Position #10, Z=354.33 (✓): __

4. Install quench antenna as available. Seal and evacuate warm bore tube.

   Required: ____ Not Required: ____

   Install antenna: (✓) YES ___ NO ___ Warm bore tube heaters OFF: (✓)___

5. Close WBT and vacuum pump on WBT. (✓) Yes ___ No ___

Table 6 - COLD

1. Quench magnet with warm bore tube at room temp. Required: ____ Not Required: ____

   Run No. _____

2. Perform 5 power cycles. Required: ____ Not Required: ____

3. Warm up warm bore tube. Required: ____ Not Required: ____

4. When the warm bore tube is warm, remove antenna. Required: ____ Not Required: ____

5. Install integral coil and complete non-rotating coil measurements.

   Required: ____ Not Required: ____

   Record Run No. _____

6. Install mole.

   Required: ____ Not Required: ____

Test Step	✓	FileName
Permanent Magnet calibrations check of measuring coil prior to testing.		
Install measuring coil into warm bore tube and establishes mole reference position with the transporter.		
Ac Cycle to 5900 amps @ 10amps/sec Runfile:1D1_LHC_AC_5900.RUN		
Dc Loop upside to 5900 amps in position #1, Z=0.00 *See Notes 1 and 2*		
Ramp down from 5900 amps @ 10 amps/sec to 25 amps		
Move mole to next position. *See Note 3*		
Dc Loop upside to 5900 amps in position #2, Z=39.37		

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Test Step	✓	FileName
Ramp down from 5900 amps @ 10 amps/sec to 25 amps.		
Move mole to next position		
Dc Loop upside to 5900 amps in position #3, Z=78.74		
Ramp down from 5900 amps @ 10 amps/sec to 25 amps		
Move mole to next position		
Dc Loop upside to 5900 amps in position #4, Z=118.11		
Ramp down from 5900 amps @ 10 amps/sec to 25 amps		
Move mole to next position		
Dc Loop upside to 5900 amps in position #5, Z=157.48		
Ramp down from 5900 amps @ 10 amps/sec to 25 amps		
Move mole to next position		
Dc Loop upside to 5900 amps in position #6, Z=196.85		
Ramp down from 5900 amps @ 10 amps/sec to 25 amps		
Move mole to next position		
Dc Loop upside to 5900 amps in position #7, Z=236.22		
Ramp down from 5900 amps @ 10 amps/sec to 25 amps		
Move mole to next position		
Dc Loop upside to 5900 amps in position #8, Z=275.59		
Ramp down from 5900 amps @ 10 amps/sec to 25 amps		
Move mole to next position		

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Test Step	✓	FileName
Dc Loop upside to 5900 amps in position #9, Z=314.96		
Ramp down from 5900 amps @ 10 amps/sec to 25 amps		
Move mole to next position		
Dc Loop upside to 5900 amps in position #10, Z=354.33		
Ramp down from 5900 amps @ 10 amps/sec to 25 amps		
Completed dc loops in 10 positions.		
Move Mole to Permanent Magnet after dc loops testing for calibration check of measuring coil. *See Note 4*		

Note 1: Ramp rate of magnet is 10 amps/sec. Dc Loop Upside current steps are as follows: 50,100,200,300,350,400 amps then 200 amp steps to 5800amps last step @ 5900 amps Runfile on VAX system: 1D1_LHC_DCLP_5900.UP. Position #5 gets Dc Loop downside, which is the same current step in reverse. Runfile on VAX system : 1D1_LHC_DCLP_5900.DN

Note 2: There are 10 Mole positions in LHC D1 magnets. The magnet has position #5 and #6 on each side of the actual cryostat center.

Note 3: If continuing in the same day testing there is no need for ac cycle to 5900 amps between dc loops. Also

Note 4: Permanent magnet checks must be done at the end of each day of testing using the measuring coil.

TESTING NOTES:

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_____

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