Fermi National Accelerator Laboratory
Batavia, IL 60510

LARGE HADRON COLLIDER
END CLAMP INSTALLATION TRAVELER

Reference Drawing(s)
Collared Coil Assembly w/Ends
ME-369580

9/28/02 117

Budget Code: LPT	**Project Code:** LHC
Released by:	**Date:** 10/3/01
Prepared by: M. Cullen, J. Larson,	

Title	Signature	Date
TD / E&F Process Engineering	Bob Jensen/Designee	9/28/01
TD /LHC Production Supervisor	Jim Rife/Designee	9/28/01
TD / LHC Production Engineer	Rodger Bossert/Designee	9/28/01
TD / LHC Tooling Engineer	John Carson/Designee	9/28/01
TD / LHC Program Manager	Jim Kerby/Designee	10/1/01

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	10/30/00
A	4.2 / 7.2	Tooling is Qty 2 of (MC-369169).		
	3.6 / 6.6	Change serial number to MQXB.	1200	9/28/01
	3.10 / 6.10	Use approved lifting fixture.		
	4.10 / 7.10	Add space for reading from all 4 quadrants.		
	3.0 / 5.0	Deleted steps for Fuji Film.		
	3.6	Grind slots on the End Rings to allow for the IORS Volt Tap Wires to pass.		
	4.0	Broke step into 3.0, 4.0 and 5.0		
	6.0	Broke step into 7.0, 8.0 and 9.0		

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Surgical Latex Gloves (Fermi stock 2250-2494) or equivalent shall be worn as required by all personnel when handling all product parts after the parts have been prepared/cleaned.

1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.

1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.

1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.

1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.

1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.

1.7 Cover the product/assembly as required, with Green Herculite (Fermi stock 1740-0100) or equivalent when not being serviced or assembled.

2.0 Parts Kit List

2.1 Attach the completed Parts Kit List for the LHC End Clamp Assembly to this traveler. Ensure that the serial number on the Parts Kit List matches the serial number of this traveler. Verify that the Parts Kit received is complete.

_____ 30 OCT 01

Process Engineering/Designee Date

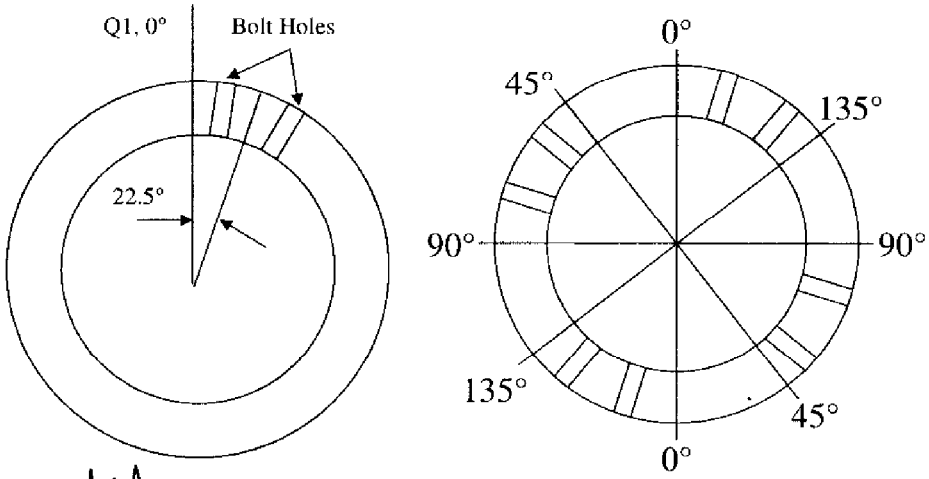
3.0 End Clamp Preparation

3.1 Clean the Tapered Ring-Return End (ME-369031) and the Filler Cone-Return End (ME-369030) with Isopropyl Alcohol (Fermi stock 1920-0300) and saturated lint free Heavy Duty Wipers (Fermi stock 1660-2600) or equivalent.

Technician(s) Date 10/3/01

3.2 On the Return End-Tapered Ring (ME-369031) find the center of a pair of boltholes. Place the Tapered Ring on the Indexing Fixture and rotate the Tapered Ring 22.5 degrees clockwise from the center of the pair of boltholes. Then mark both of the 0, 45, 90, and 135-degree positions.

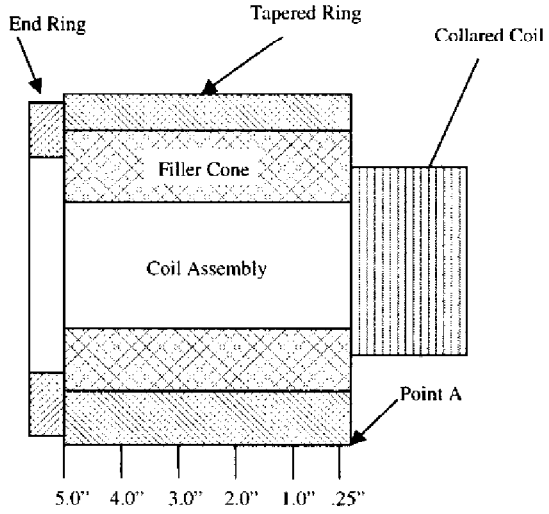
View from the Return End looking toward the Lead End

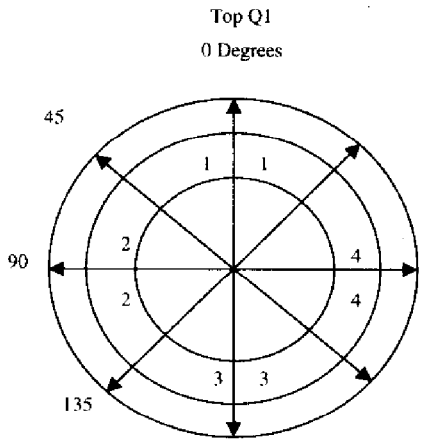


Technician(s) Date 10/4/01

3.3 Measure the diameter of the Tapered Ring-Return End (ME-369031) in the free state in the 0, 45, 90 and 135 degree directions at 1" intervals using a 9"-10" Micrometer and a Pi Tape. Use a fine tip marker (not black) to mark the intervals on the Tapered Ring from point A.

View from the Return End looking toward the Lead End





Distance from the Coil End of the Tapered Ring (A)	0 Degrees	45 Degrees	90 Degrees	135 Degrees	Pi Tape
0.25 inches	9.840	9.8395	9.840	9.840	9.840
1.0 inches	9.840	9.840	9.840	9.840	9.840
2.0 inches	9.840	9.8395	9.840	9.840	9.840
3.0 inches	9.840	9.840	9.840	9.840	9.840
4.0 inches	9.840	9.840	9.840	9.8395	9.840
5.0 inches	9.8395	9.8395	9.8395	9.8395	9.840

Technician(s)

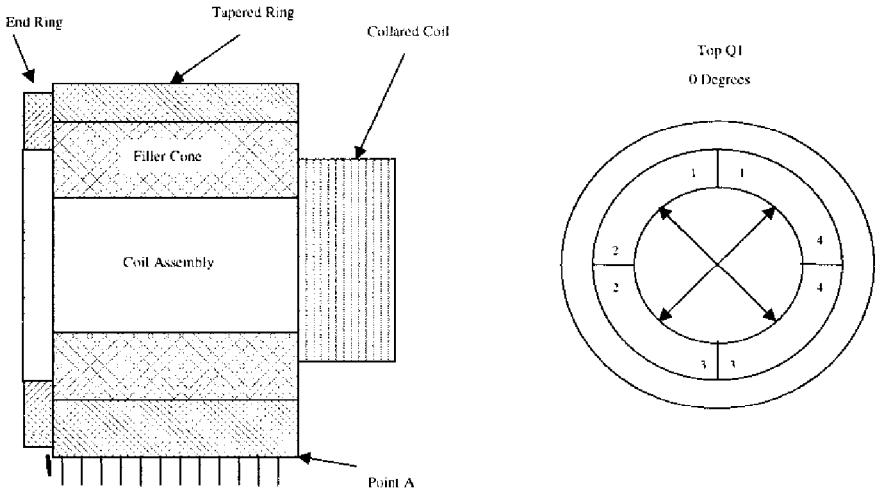
Date 10/8/01

3.4 Position the Filler Cone-Return End (ME-369030) in the Aluminum Tapered Ring (ME-369031). If the Filler Cone is too loose, add shims until it becomes necessary to use a rubber mallot on the partially inserted shims.

Technician(s) 11/8/01 Date

3.5 Mark with a fine tip marker (not black) and measure the Filler Cone Inner Diameter from the center of Quadrants 1 to 3 and the center of Quadrants 2 to 4, at all intervals marked on table below, using a Telescoping Micrometer and a Dial Caliper. Record data in table below.

View from the Return End looking toward the Lead End



Note(s):

Measure to three digits past the decimal point

Distance from the Coil End of the Tapered Ring (A)	Diameter Filler Cones 1,2 to 3,4	Diameter Filler Cones 2,3 to 1,4
0.25 inches	5.2750	5.276
1.00 inches	5.2745	5.275
4.00 inches	5.2775	5.277
4.75 inches	5.278	5.278

Technician(s) Date 11/8/01

3.6 Etch the Magnet Serial Number MQXBC-XXX, using .025 to .0375 inch high letters, onto both End Can End Ring (MB-344533) on the Lead and Return Ends. Grind slots into the End Can End Ring (MB-344533) on the Lead and Return Ends to allow for the IORS Volt Tap Wires to pass.

Technician(s) _____ Date 11/8/01

3.7 Score the Inside of the Filler Cone.

Technician(s) _____ Date 11/8/01

3.8 Clean the inside of the Filler Cone with lint free Heavy Duty Wipers (Fermi stock 1660-0150), and Isopropyl Alcohol (Fermi stock 1920-0300) or equivalent.

Technician(s) _____ Date 11/8/01

3.9 Coat the inside of the Aluminum Tapered Ring-Return End (ME-369031), the outside faces and the Preform slots of the Filler Cone-Return End (ME-369030) with Dry Lubricant Spray (Miller Stephenson MS-122N/002). Apply 2nd coat after 5 minutes drying time.

Note(s):

Ensure dry lubricant contacts only the outside, Tapered Ring surfaces and Preform slots of the Filler Cone, and not the Lead End surfaces.

Technician(s) _____ Date 11-9-01

3.10 Pick up the Collared Coil Assembly with Crane (using the LHC Lifting Fixture 318718) and place it into End Squeezer Assembly (ME-344350).

Note(s):

All wires shall be clear of the End Squeezer Assembly (ME-344350) prior to installation. "Peel back" the Strain Gage Wires 24 inches to avoid any pinching or damage to the wires during the end clamp procedure.

Technician(s) _____ Date 11/9-01

4.0 Return End End Can Installation

4.1 Slide the Tapered Ring-Return End (ME-369031) using a Mylar sleeve, onto the Collared Coil.

Technician(s) 11-12-01 Date

4.2 Bolt the (2) Pusher Plates (MC-369169) with 0.50 inch-13UNC x 13.0 inch Socket Head Cap Screws and 0.50 inch Flat Washers, onto the End Squeezer Assembly (ME-344350).

Note(s):

Pusher Plates must be installed with hydraulic cylinder sides facing towards center of Coil as not to interfere with any wiring involved in Lead End Assembly.

Technician(s) 11-12-01 Date

4.3 Install the Kapton and the Filler Cone (MC-344457) atop the Saddles with Plastic Cable ties.

Caution:

Ensure dry lubricant coating remains intact and free of damage.

Record the amount of Kapton used:

.003

Technician(s) 11-12-01 Date

4.4 Slide the Tapered Ring-Return End (ME-369031) on the Filler Cone-Return End (ME-369030) as per the Collared Coil with Ends (ME-369580).

Note(s):

Top of the Tapered Ring and the top of the Collared Coil match.
Strain Gage wires are on the outside of the Aluminum Tapered Ring.
Voltage Tap Wires are extended through the inside of the Aluminum Tapered Ring.

Technician(s) 11-12-01 Date

4.5 Position the Holder Plate with the installed Half Rings (MC-344359), until it contacts the back surface of the Filler Cone (ME-369030).

Technician(s) 11-12-01 Date

4.6 Attach the Enerpac Hose to Hydraulic Cylinders (Model RC 106) as per the End Squeezer Assembly (ME-344350).

Note(s):

Face shield must be worn during operation of hydraulic cylinders.

Technician(s) 11-12-01 Date

4.7 Record Total Coil Starting Resistance 2309 Ω.

Technician _____ Date 11-12-01

4.8 Gradually apply pressure to the End Squeezer Assembly until the Aluminum Tapered Ring covers the Filler Cone. Maximum pump pressure is to be greater than 4000psi.

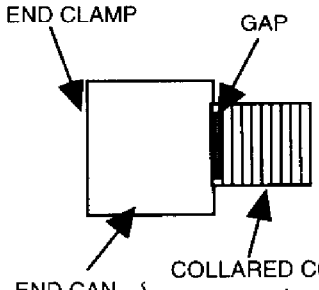
Maximum Pump Pressure 3500

Technician(s) _____ Date 11-12-01

4.9 Record Total Coil End Resistance 2.309 Ω

Technician _____ Date 11-12-01

4.10 Before removing the End Squeezer Assembly, measure the gap between the Filler Cone and the Coil Lamination, as shown below, using a Micrometer.



Gap Measurement Quad 1 .019

Gap Measurement Quad 2 .012

Gap Measurement Quad 3 .025

Gap Measurement Quad 4 .024

Technician(s) _____ Date 11-12-01

STOP

4.11 Verify that the results in Step 4.10 are acceptable.
Approved for next Assembly Procedure.

Responsible Authority/Physicist _____ Date 11/12/01

4.12 Remove the End Squeezer Assembly.

Technician(s) _____ Date 11-12-01

5.0 Return End Can Inspection

TAK 1290

5.1 Perform a Pi tape measurement on the Tapered Ring at the following locations.

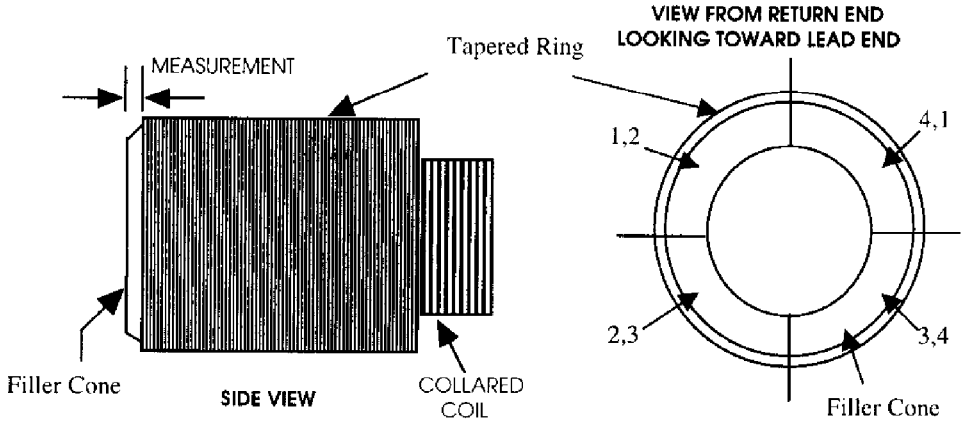
Distance from the Coil End of the Tapered Ring (A)	Pi Tape
0.0 inches	9.852
1.0 inches	~~9.856~~ 9.851
2.0 inches	9.850
3.0 inches	~~9.853~~ 9.849
4.0 inches	~~9.850~~ 9.848
5.0 inches	~~9.852~~ 9.849

Technician(s) 11-12-01 Date

5.2 Clean the Filler Cone using Isopropyl Alcohol (Fermi stock 1920-0300) Kimwipes (Fermi stock 1660-2600) or equivalent.

Technician(s) 11-12-01 Date

5.3 Measure the distance between each Filler Cone and the Tapered Ring, using a Depth Gauge.

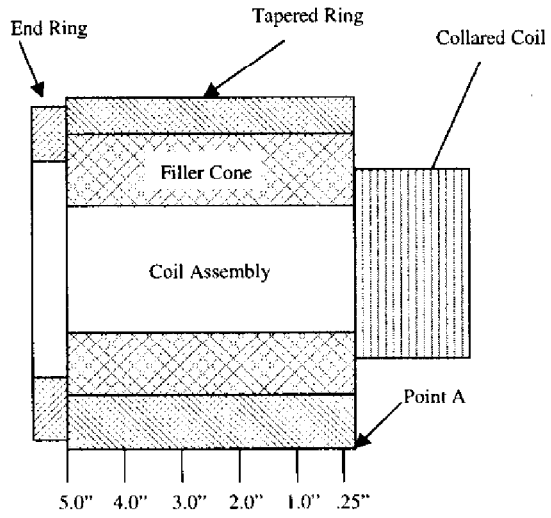


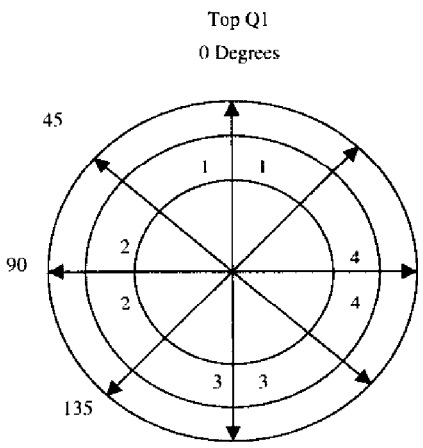
Filler Cone 1,2	.003
Filler Cone 2,3	.002
Filler Cone 3,4	.002
Filler Cone 1,4	.003
AVERAGE	.0025

Technician(s) 11-12-01 Date

5.4 Measure the diameter of the Tapered Ring (MC-344456) in the fully clamped state, at 0, 45, 90 and 135 Degrees at 1" intervals using a 9"-10" Micrometer and PI Tape.

View from the Return End looking toward the Lead End





Distance from the Coil End of the Tapered Ring (A)	0 Degree	45 Degree	90 Degree	135 Degree	Pi Tape
0.0 inches	9.853	9.851	9.851	9.851	9.852
1.0 inches	9.8535	9.853	9.851	9.850	~~9.856~~ 9.851
2.0 inches	9.853	9.853	9.851	9.847	9.850
3.0 inches	9.852	9.849	9.849	9.848	~~9.853~~ 9.849
4.0 inches	9.855	9.851	9.8495	9.848	~~9.853~~ 9.849
5.0 inches	9.853	9.849	9.850	9.848	~~9.857~~ 9.849

Technician(s)

Date

5.5 Perform an electrical inspection on each of the individual Inner Coils, Outer Coils, Quadrants and Voltage Taps. Refer to the Valhalla and Leader Free Standing Coil Measurement Procedure (ES-292306), and the Procedure for Electrical Inspection of Voltage Taps (ES-301383).

Note(s):

Ensure that all measurements are recorded correctly, and have the proper value and symbol (i.e., mΩ, mH, etc.).

Valhalla 4300B settings:

Test current	_____	Off (not testing)
Power	_____	On
Full scale voltage	_____	20mv
Amp selector knob	_____	1 A
Temperature compensator	_____	On
Test current	_____	On (testing)

Hp 4263 B:

Function	_____	"Ls-Q" selected

Record the Serial Number of the test equipment used.

Valhalla _____

HP 4263b _____

Resistance		Inner	Outer	Total	Pass	Fail
Nominal		345 mΩ to 390 mΩ	410 mΩ to 455 mΩ	560 to 585 mΩ		
Quadrant 1	Inner	.2568 mΩ				
	Outer		.3192 mΩ			
	Total			.5759 mΩ		
Quadrant 2	Inner	.2579 mΩ				
	Outer		.3190 mΩ			
	Total			.5768 mΩ		
Quadrant 3	Inner	.2578 mΩ				
	Outer		.3173 mΩ			
	Total			.5748 mΩ		
Quadrant 4	Inner	.2575 mΩ				
	Outer		.3190 mΩ			
	Total			.5766 mΩ		
Total Magnet		Nominal	2.3 Ω	2.307 Ω		

Inductance		Inner	Outer	Total	Pass	Fail
Nominal		620-650 µH	1.120 to 1.17 mH	2.880 to 2.935 mH		
Quadrant 1	Inner	880.074 µH				
	Outer		1.22215 mH			
	Total			2.33013 mH		
Quadrant 2	Inner	841.541 µH				
	Outer		1.18314 mH			
	Total			2.33185 mH		
Quadrant 3	Inner	947.022 µH				
	Outer		1.22772 mH			
	Total			2.33384 mH		
Quadrant 4	Inner	898.341 µH				
	Outer		1.14426 mH			
	Total			2.33742 mH		
Total Magnet		Nominal	17 mH	13.1678 mH		

Q-Factor		Inner	Outer	Total	Pass	Fail
Nominal		3.0 to 3.5	4.3 to 5.0	4.5 to 5.2		
Quadrant 1	Inner	2.11				
	Outer		2.30			
	Total			5.34		
Quadrant 2	Inner	2.04				
	Outer		2.24			
	Total			5.33		
Quadrant 3	Inner	1.97				
	Outer		2.20			
	Total			5.34		
Quadrant 4	Inner	2.20				
	Outer		2.35			
	Total			5.36		
Total Magnet		Nominal	4.3	6.06		

Inspector

11/12/01
Date

Electrical Test	Limit	Actual Measurement	Pass	Fail
Heater Strips 1/2 Resistance	9.20 to 9.60 Ω	9.221 Ω		
Heater Strips 2/3 Resistance	9.20 to 9.60 Ω	9.231 Ω		
Heater Strips 3/4 Resistance	9.20 to 9.60 Ω	9.263 Ω		
Heater Strips 4/1 Resistance	9.20 to 9.60 Ω	9.214 Ω		

TGH 1290

Voltage Taps	Iors (ramp splice) 1/8 Coil Taps	Pass	Fail
Quadrant 1	mV		
Quadrant 2	mV		
Quadrant 3	mV		
Quadrant 4	mV		

Inspector

11-12-01
Date

Perform a Hipot on the Collared Coil Assembly (**Maximum Leakage 2.5μA**)

5 KV	Measurement(s)
Heater #1/2 to Ground	
Heater #2/3 to Ground	
Heater #3/4 to Ground	
Heater #4/1 to Ground	
Heater #1/2 to All 4 Quadrants	
Heater #2/3 to All 4 Quadrants	
Heater #3/4 to All 4 Quadrants	
Heater #4/1 to All 4 Quadrants	
All 4 Quadrants to Ground	

COIL TO COIL 3.0 KV	Measurement(s)
Quadrant 1 to Quadrant 2	
Quadrant 2 to Quadrant 3	
Quadrant 3 to Quadrant 4	
Quadrant 4 to Quadrant 1	

Inspector _____ Date _____

STOP

5.6 Verify that the results in Step 5.5 are acceptable.
Approved for next Assembly Procedure.

Responsible Authority/Physicist — Date: 11-12-01

5.7 Thread the Voltage Taps, and Heater Strips through the openings of the End Can End Ring (MB-344533).

Technician(s) — Date: 11-12-01

5.8 Place the End Can End Ring (MB-344533) onto the Tapered Ring (MC-344456).

Technician(s) — Date: 11-12-01

5.9 Remove the old Strain Gage Wire RTV from the top and bottom instrumentation slots of the Collared Coil at both Return and Lead ends (only from areas where Strain Gage Wires had originally been "peeled back"). Re-apply Silicone Rubber Primer (Fermi-Stock 1940-1300) or equivalent onto the instrumentation slots and secure Strain Gage Wires into position with a mixture of RTV (Fermi-Stock 1940-0750) or equivalent.

Technician(s) — Date

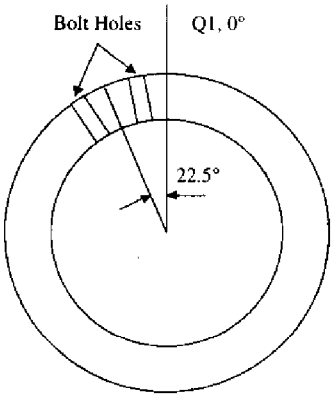
6.0 Lead End Clamp Preparation

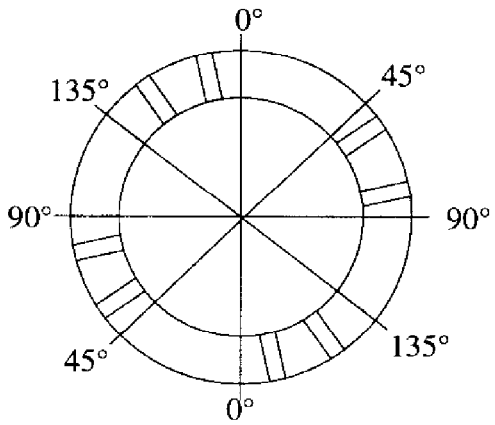
6.1 Clean the Tapered Ring (MC-344456) and Filler Cone (MC-344457) with Isopropyl Alcohol (Fermi stock 1920-0300) and saturated lint free Heavy Duty Wipers (Fermi stock 1660-2600) or equivalent.

Technician(s) _____ Date 11/8/01

6.2 On the Lead End Tapered Ring find the center of a pair of boltholes. Place the Tapered Ring on the Indexing Fixture and rotate the Tapered Ring 22.5 degrees counter clockwise from the center of the pair of boltholes. Then mark both of the 0, 45, 90, and 135-degree positions.

View from the Lead End looking toward the Return End

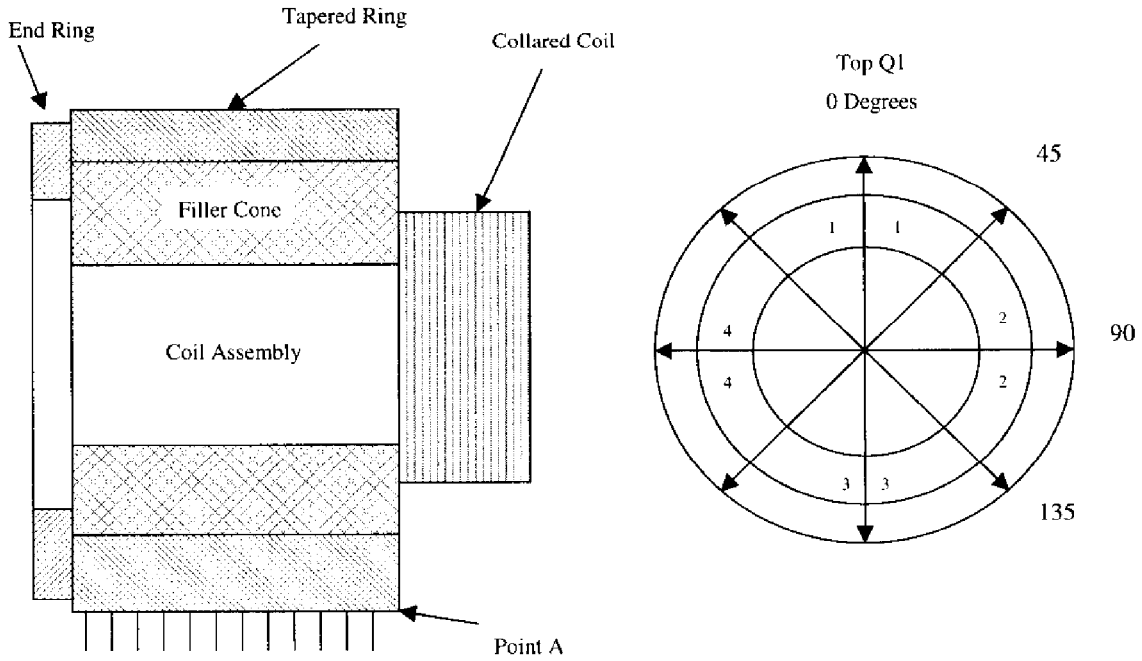




Technician(s) _____ Date 11/8/01

6.3 Measure the diameter of the Tapered Ring (MC-344456) in the free state in the 0, 45, 90 and 135 degree directions at 1" intervals using a 9"-10" Micrometer and a Pi Tape. Use a fine tip marker (not black) to mark the Tapered Ring from point A. Mark the "TOP" of the Tapered Ring.

View from the Lead End looking toward the Return End



Distance from the Coil End of the Tapered Ring (A)	0 Degree	45 Degree	90 Degree	135 Degree	Pi Tape
0.0 inches	9.840	9.8395	9.8395	9.8 395	9.839
1.0 inches	9.8 40	9.8 395	9.8 395	9.8 40	9.8 40
2.0 inches	9.8 395	9.8 39	9.8 395	9.8 395	9.8 40
3.0 inches	9.8 40	9.8 39	9.8 395	9.8 395	9.8 39
4.0 inches	9.8 40	9.8 395	9.8 395	9.8 395	9.8 39
5.0 inches	9.8 40	9.8 395	9.8 395	9.8 395	9.8 40
6.0 inches	9.8 40	9.8 395	9.8 395	9.8 395	9.8 39
7.0 inches	9.8 40	9.8 395	9.8 395	9.8 39	9.8 40
8.0 inches	9.8 395	9.8 395	9.8 395	9.8 39	9.8 40
9.0 inches	9.8 395	9.8 395	9.8 39	9.8 385	9.8 40
9.5 inches	9.8 395	9.8 395	9.8 40	9.8 40	9.840

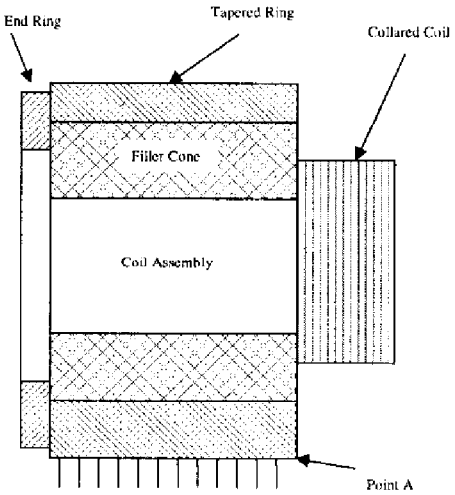
Technician(s) _____ Date 11/8/01

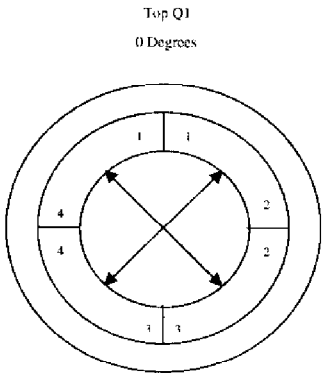
6.4 Position the Filler Cone Lead End (ME-344457) into the Aluminum Tapered Ring Lead End (ME-344456). If the Filler Cone is too loose, increase the shims until it becomes necessary to use a rubber mallot on the partially inserted shims.

Technician(s) _____ Date 11/8/01

6.5 Mark using a fine tip marker (not black) and measure the Filler Cone Inner Diameter from the center of Quadrants 1 to 3 and the center of Quadrants 2 to 4, at all intervals marked on table below, using a Telescoping Micrometer and a Dial Caliper. Record data in table below.

View from the Lead End looking toward the Return End





Distance from the Coil End of the Tapered Ring (**A**)	Diameter Filler cone 1,4 to 2,3	Diameter Filler Cone 1,2 to 3,4
0.25 inches	5.2445	5.25
1.00 inches	5.2520	5.253
9.00 inches	5.2725	5.2725
9.50 inches	5.2715	5.2760

Technician(s) _____ Date 11/8/01

Already Done TRR 12-4-01

6.6 Etch the Magnet Serial Number MQXBC-XXX, using 0.25 to .0.375 inch high letters, onto both End Can End Rings (MB-344533) on the Lead and Return Ends.

N/A
Technician(s) Date

6.7 Score the Inside of the Filler Cone

Technician(s) 11/8/01
Date

6.8 Clean the inside of the Filler Cone with lint free Heavy Duty Wipers (Fermi stock 1660-0150), and Isopropyl Alcohol (Fermi stock 1920-0300) or equivalent.

Technician(s) 11-12-01
Date

6.9 Coat the inside of the Aluminum Tapered Ring (MC-344456), the outside faces and the Preform slots of the Filler Cones (MC-344457) with Dry Lubricant Spray (Miller Stephenson MS-122N/002). Apply 2nd coat after 5 minutes drying time.

Note(s):

Ensure dry lubricant contacts only the outside, Tapered Ring surfaces and Preform slots of the Filler Cone, and not the Lead End surfaces.

Technician(s) 11-12-01
Date

6.10 Pick up the Collared Coil Assembly with Crane (using slings) and place it into End Squeezer Assembly (ME-344350).

12-5-01

Note(s):

All wires shall be clear of the End Squeezer Assembly (ME-344350) prior to installation. "peel back" the Strain Gage Wires 24 inches to avoid any pinching or damage to the wires during the end clamp procedure.

N/A
Technician(s) Date

7.0 Lead End Can Installaation

7.1 Slide the Tapered Ring (MC-344456) using a Mylar sleeve, onto the Collared Coil.

Technician(s) 11-12-01 Date

7.2 Bolt the (2) Pusher Plates (MC-369169) with .50 inch-13UNC x 13.0 inch Socket Head Cap Screws and 1/2" Flat Washers, onto the End Squeezer Assembly (ME-344350).

Note(s):

Pusher Plates must be installed with hydraulic cylinder sides facing towards center of the Coil as not to interfere with any wiring involved in the Lead End Assembly.

Technician(s) 11-12-01 Date

7.3 Install the Kapton and the Filler Cone (MC-344457) atop the Saddles with Plastic Cable ties.

Caution:

Ensure dry lubricant coating remains intact and free of damage.

Record the amount of Kapton used: .005

Technician(s) 11-12-01 Date

X 7.4 Slide the Tapered Ring Lead End (ME-344456) on to the Filler Cone Lead End (ME-344457) as per the Collared Coil with Ends (ME-369580).

Note(s):

Top of the Tapered Ring and the top of the Collared Coil match.
Strain Gage wires are on the outside of the Aluminum Tapered Ring.
Voltage Tap Wires are extended through the inside of the Aluminum Tapered Ring.

Technician(s) _____ Date 11-12-01

7.5 Position the Holder Plate with the installed Half Rings (MC-344359), until it contacts the back surface of the Filler Cone (ME-344457).

Technician(s) _____ Date 11-12-01

7.6 Attach the Enerpac Hose to the Hydraulic Cylinders (Model RC 106) as per the Collared Coil End Squeezer Assembly (ME-344350).

Note(s):

Face shield must be worn during operation of hydraulic cylinders.

Technician(s) _____ Date 11-12-01

7.7 Record Total Coil Starting Resistance 2.305 Ω.

Technician _____ Date 11-12-01

7.8 Gradually apply pressure to the End Squeezer Assembly until the Aluminum Tapered Ring covers the Filler Cone. Maximum Pump pressure is to be greater than 4000psi.

Maximum Pump Pressure 9000

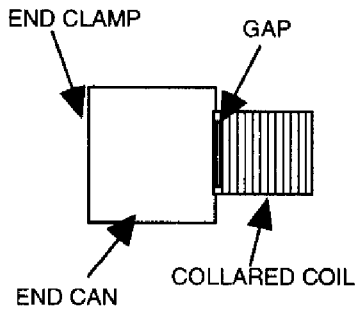
Technician(s) _____ Date 11-12-01

7.9 Record Total Coil End Resistance 2.305 Ω

Technician _____ Date 11-12-01

7.10 Before removing the End Squeezer Assembly, measure the gap between the Filler Cone and the Coil Lamination, as shown below, using a Micrometer. The gap should be no more than 10 mils.

TCR # 1422



Gap Measurement Quad 1 .015

Gap Measurement Quad 2 .018

Gap Measurement Quad 3 .020

Gap Measurement Quad 4 .021

Technician(s) 11-12-01 Date

STOP

WRITE TCR ON 7.10 TOLERANCE

7.11 Verify that the results in Step 7.10 are acceptable.
Approved for next Assembly Procedure.

Responsible Authority/Physicist 11-12-01 Date

7.12 Remove the entire End Squeezer Assembly.

Technician(s) 11-12-01 Date

8.0 Lead End Can Inspection

TTR 1298

8.1 Perform a Pi tape measurement on the Tapered Ring at the following locations.

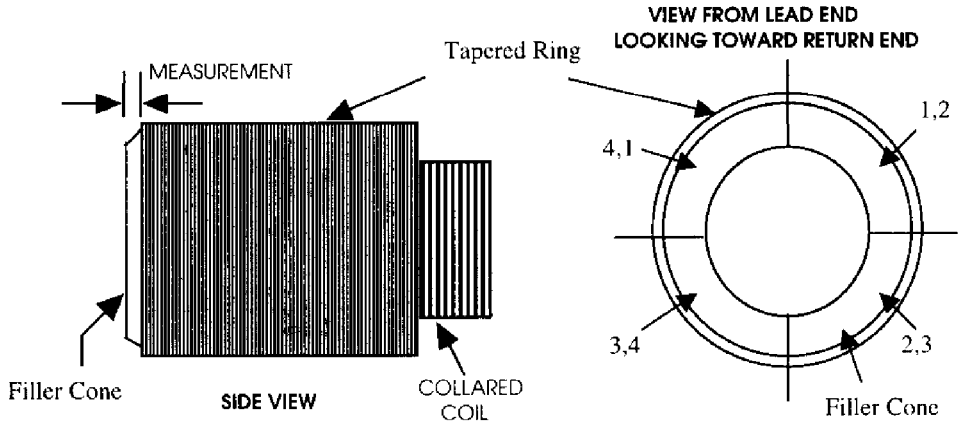
Distance from the Coil End of the Tapered Ring (A)	Pi Tape
0.0 inches	9.852
1.0 inches	9.850
2.0 inches	9.852
3.0 inches	9.852
4.0 inches	9.853
5.0 inches	9.853

Technician(s) Date 11-2-01

8.2 Clean the Filler Cone using Isopropyl Alcohol (Fermi stock 1920-0300) and Kimwipes (Fermi stock 1660-2600) or equivalent.

Technician(s) Date 11/2/01

8.3 Measure the distance between each Filler Cone and the Tapered Ring, using a Depth Gauge.



Filler Cone 1,2 .003

Filler Cone 2,3 .010

Filler Cone 3,4 .009

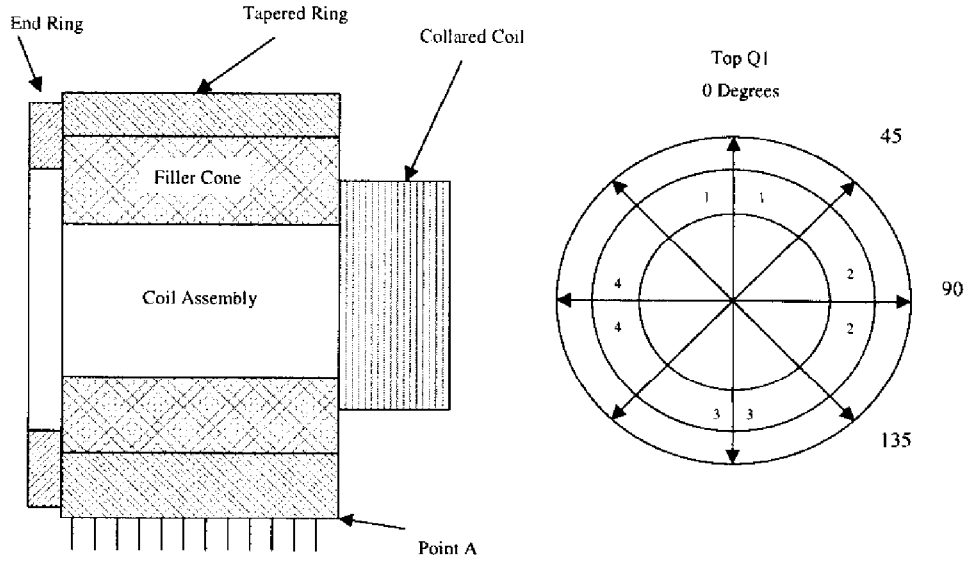
Filler Cone 1,4 .011

AVERAGE .00825

Technician(s) Date 11-2-01

8.4 Measure the diameter of the Tapered Ring (MC-344456) in the fully clamped state, at the 0, 45, 90 and 135 Degrees at 1" intervals using a 9"-10" Micrometer and PI Tape.

Looking from the Lead End to the Return End



Distance from the Coil End of the Tapered Ring (A)	0 Degrees	45 Degree	90 Degree	135 Degree	Pi Tape
0.00 inches	9.852	9.851	9.8505	9.852	9.852
1.00 inches	9.852	9.8505	9.8505	9.851	9.850
2.00 inches	9.8525	9.851	9.851	9.851	9.852
3.00 inches	9.853	9.851	9.850	9.852	9.852
4.00 inches	9.854	9.851	9.850	9.852	9.853
5.00 inches	9.854	9.8515	9.850	9.852	9.853
6.00 inches	9.854	9.851	9.8495	9.852	9.853
7.00 inches	9.854	9.8515	9.848	9.852	9.853
8.00 inches	9.854	9.851	9.847	9.8515	9.853
9.00 inches	9.855	9.8515	9.848	9.852	9.853
9.50 inches	9.855	9.852	9.848	9.852	9.854

Technician(s)

11+20/
Date

8.5 Perform an electrical inspection on each of the individual Inner Coils, Outer Coils, Quadrants and Voltage Taps. Refer to the Valhalla and Leader Free Standing Coil Measurement Procedure (ES-292306), and the Procedure for Electrical Inspection of Voltage Taps (ES-301383).

Note(s):

Ensure that all measurements are recorded correctly, and have the proper value and symbol (i.e., mΩ, mH, etc.).

Valhalla 4300B settings:

Test current	Off (not testing)
Power	On
Full scale voltage	20mv
Amp selector knob	1 A
Temperature compensator	On
Test current	On (testing)

Hp 4263 B:

Function	"Ls-Q" selected

Record the Serial Number of the test equipment used.

Valhalla 32-858

HP 4263b 2848J00912

Resistance		Inner	Outer	Total	Pass	Fail
Nominal		345 mΩ to 390 mΩ	410 mΩ to 455 mΩ	560 to 585 mΩ		
Quadrant 1	Inner	.2567 mΩ				
	Outer		.3188 mΩ			
	Total			.5755 mΩ		
Quadrant 2	Inner	.2574 mΩ				
	Outer		.3186 mΩ			
	Total			.5760 mΩ		
Quadrant 3	Inner	.2575 mΩ				
	Outer		.3186 mΩ			
	Total			.5754 mΩ		
Quadrant 4	Inner	.2572 mΩ				
	Outer		.3186 mΩ			
	Total			.5758 mΩ		
Total Magnet		Nominal	2.3 Ω	2.299 Ω		

Inductance		Inner	Outer	Total	Pass	Fail
Nominal		620-650 µH	1.120 to 1.17 mH	2.880 to 2.935 mH		
Quadrant 1	Inner	RE: 911.78µH				
	Outer		1.25534 mH			
	Total			2.31951 mH		
Quadrant 2	Inner	870.993µH				
	Outer		1.20910 mH			
	Total			2.32293mH		
Quadrant 3	Inner	867.370 µH				
	Outer		1.19932 mH			
	Total			2.32246mH		
Quadrant 4	Inner	908.914µH				
	Outer		1.26177 mH			
	Total			2.32757mH		
Total Magnet		Nominal	17 mH	13.3394 mH		

Q-Factor		Inner	Outer	Total	Pass	Fail
Nominal		3.0 to 3.5	4.3 to 5.0	4.5 to 5.2		
Quadrant 1	Inner	2.09				
	Outer		2.27			
	Total			5.32		
Quadrant 2	Inner	1.96				
	Outer		2.16			
	Total			5.31		
Quadrant 3	Inner	1.83				
	Outer		2.06			
	Total			5.35		
Quadrant 4	Inner	2.14				
	Outer		2.30			
	Total			5.34		
Total Magnet		Nominal	4.3	5.96		

Inspector

11-13-01
Date

Electrical Test	Limit	Actual Measurement	Pass	Fail
Heater Strips 1/2 Resistance	9.20 to 9.60 Ω	9.209 Ω	✓	
Heater Strips 2/3 Resistance	9.20 to 9.60 Ω	9.193 Ω	✓	
Heater Strips 3/4 Resistance	9.20 to 9.60 Ω	9.257 Ω	✓	
Heater Strips 4/1 Resistance	9.20 to 9.60 Ω	9.190 Ω	✓	

TAF
12/99

Voltage Taps	Iors (ramp splice) 1/8 Coil Taps	Pass	Fail
Quadrant 1	N/A mV		
Quadrant 2	N/A mV		
Quadrant 3	N/A mV		/
Quadrant 4	N/A mV		

NA
Inspector

Date

Perform a Hipot on the Collared Coil Assembly (**Maximum Leakage 2.5μA**)

TRR# 1299

DR # HGQ-0275

5 KV	Measurement(s)
Heater #1/2 to Ground	
Heater #2/3 to Ground	
Heater #3/4 to Ground	
Heater #4/1 to Ground	
Heater #1/2 to All 4 Quadrants	
Heater #2/3 to All 4 Quadrants	
Heater #3/4 to All 4 Quadrants	
Heater #4/1 to All 4 Quadrants	
All 4 Quadrants to Ground	

COIL TO COIL 3.0 KV	Measurement(s)
Quadrant 1 to Quadrant 2	
Quadrant 2 to Quadrant 3	
Quadrant 3 to Quadrant 4	
Quadrant 4 to Quadrant 1	

NA

Inspector

Date

8.6 Verify that the results in Step 8.5 are acceptable.
Approved for next Assembly Procedure.

Responsible Authority/Physicist _____ Date _____

8.7 Thread the Coil Leads, Voltage Taps and Heater Strips through the openings of the End Can End Ring (MB-344533).

Technician(s) _____ Date 12-30

8.8 Place the End Can End Ring (MB-344533) onto the Tapered Ring (MC-344456).

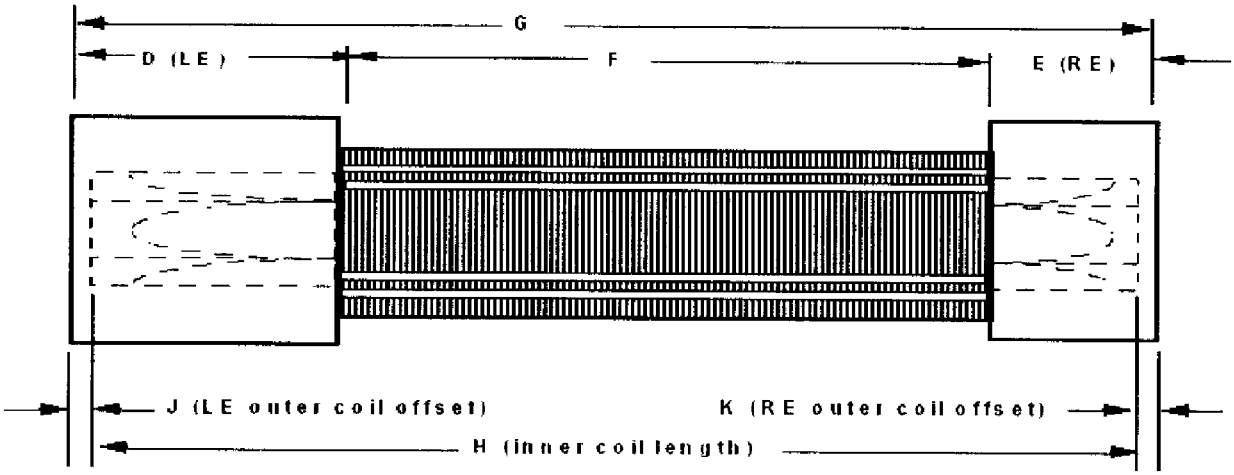
Technician(s) _____ Date 12-30-01

8.9 Remove the old Strain Gage Wire RTV from the top and bottom instrumentation slots of the collared coil at both return and lead ends (only from areas where Strain Gage Wires had originally been "peeled back"). Re-apply Silicone Rubber Primer (Fermi stock 1940-1300) or equivalent onto the instrumentation slots and secure Strain Gage Wires into position with a mixture of RTV (Fermi stock 1940-0750) or equivalent.

Technician(s) _____ Date _____

9.0 Mechanical measurements after installing the End Clamps

9.1 (D+E) Measure the length of the Tapered Rings using the (Starrett 120-12) or equivalent
(F) Measure the length of exposed Collared Coil using a Ruler to the closest 1/32"
(G) Measure the distance between the outside of the Tapered Rings using a ruler to the closest 1/32"



Keyed body and end Measurements after End Can Installation

Quadrant	D	E	F	G
1	9.828	5.193	17' 1.491"	18'4.512"
2	9.826	5.191	17' 1.510	18'4.527"
3	9.828	5.190	17'1.475	18'4.493
4	9.833	5.192	17'1.518	18'4.593

Technician(s) 12-3-01 Date

9.2 (H) Measure the length of the Inner Coils with a standard tape through the bore.
(J+K) Measure the offset of the Outer Coil and the Tapered Ring

Quadrant	H	"J" Offset	"K" Offset
1	221 3/16	~~.008~~ .308	~~.002~~ .450
2	221 3/16	~~.007~~ .281	~~.003~~ .366
3	221 1/8	~~.011~~ .298	~~.004~~ .425
4	221 1/8	~~.010~~ .3155	~~.007~~ .4225

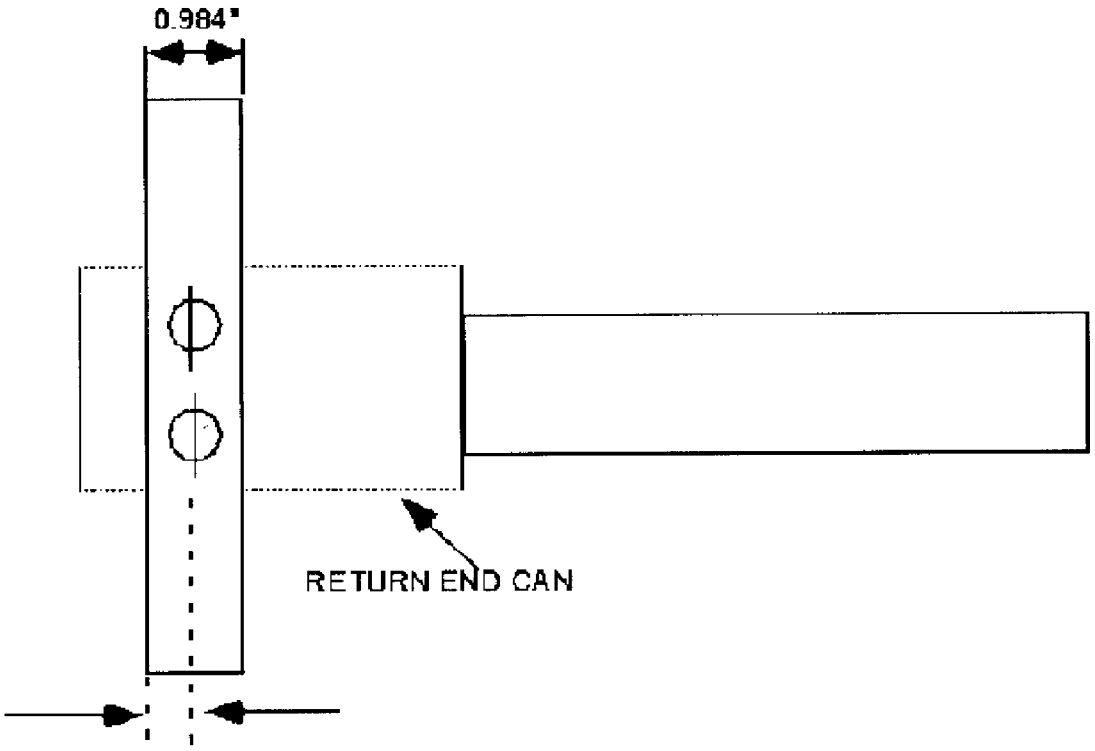
Technician(s) 12-3-01 Date

10.0 Install End Axial Preload Plates

10.1 Obtain (1) Axial Preload Plate (MD-369094), and bolt it onto the Outer surface of Return End Tapered Ring as shown.

Note(s):

Make sure that the thicker wall of the Plate is towards the outside directing Return End.



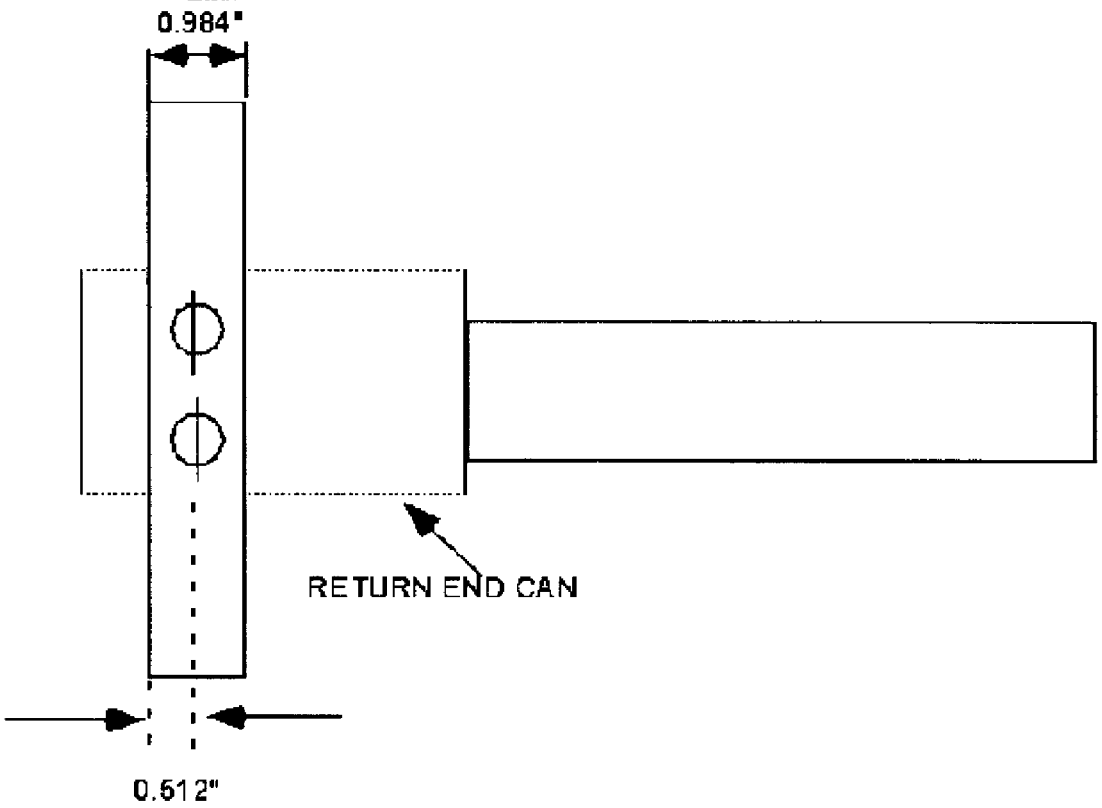
Technician(s)

12-03-01
Date

10.2 Obtain (1) Axial Preload Plate (MD-369094), and bolt it onto the Outer surface of Lead End Tapered Ring as shown.

Note(s):

Make sure that the thicker wall of the Plate is towards the outside directing Lead End.



Technician(s)

12-3-01
Date

11.0 Mole Measurement

11.1 Perform a "Mole Measurement Run" on the coils per Procedure (ES-292481). Attach the completed ES to this traveler.

DR# 0292

Technician

12/13/2001
Date

12.0 Production Complete

12.1 Process Engineering verify that the Large Hadron Collider End Clamp Installation Assembly Traveler (TR-333496) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance, Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

Process Engineering/Designee

9/28/02
Date

TD/ENGINEERING & FABRICATION

PARTS KIT REQUEST

ORIGINAL

IMPORTANT NOTES:
1) MAGNET NUMBER MUST BE FILLED IN.
2) ONLY ONE FORM PER MAGNET.
3) PARTS COORDINATOR OR DESIGNEE MUST SIGN THIS FORM.
4) MATERIAL CONTROL WILL ISSUE PARTS AND RECORD ROUTING NUMBER.
5) ANY QUANTITIES NOT AVAILABLE WILL HAVE COMMENTS RETURNED TO THE PARTS COORDINATOR FOR REVIEW.

DELIVER TO _____ ICB

BUDGET CODE: 48

COLLARED COIL NUMBER:	MQXBc-002
RELEASED BY PRODUCTION SIGNATURE:	T. Gardner
TODAYS DATE:	7-Sep-01
NEED DATE:	12-Sep-01

ISSUE VERIFICATION
MATERIAL CONTROL SIGNATURE: Marsha Schmidt
DATE ISSUED TO STOCKROOM: 9/7/01

THIS KIT LIST IS FOR:

ME-369580	B	COLLARED COIL WITH ENDS ASSEMBLY

					MATERIAL CONTROL					PROD	SUPT.
					QTY FILLED OUT BY STOCK ROOM			FILLED OUT BY EXPEDITER		VERIFY	VERIFY
PART NUMBER	REV	DESCRIPTION	REQUIRED QTY/ASS'Y		ISSUED	ROUTE FORM	NOT AVAIL	DATE AVAIL	COMMENTS TO PRODUCTION MANAGER	PART	PART
344456	G	LE TAPERED RING	1	EA	1	74531		9/7/01			
344533	B	END CAN END RING	2	EA	2	72461		↓			
369031	D	RE TAPERED RING	1	EA	1	74445					
369094	B	AXIAL PRELOAD PLATE	2	EA	2	72450					
369719		1/2-13 X 1.5" LG SOCKET HEAD CAP SCREW	16	EA	16	71429					
369272	B	7/16-14 X 3/4" LG FLAT HEAD SCREW	8	EA	8	71428		↓			
369581	B	COLLARED COIL WITHOUT END ASSEMBLY	IB3	HAS				—			
369751		RE FILLER CONE (4 PCS TO A SET)	1	SET	1 SET	74530		9/7/01			
369752		LE FILLER CONE (4 PCS TO A SET)	1	SET	1 SET	74529		↓			

RETURN THIS COMPLETED PARTS KIT REQUEST WITH THE ISSUED PARTS TO THE PARTS COORDINATOR.

Jeff Bauer 9/12/01 : STOCKROOM SIGNATURE AND DATE

TRAVELER NO. TR-333496

KIT IS COMPLETE (PARTS COORDINATOR SIGNATURE): _____ BADGE # 489

DATE 12SEP01

TD / Engineering Fabrication

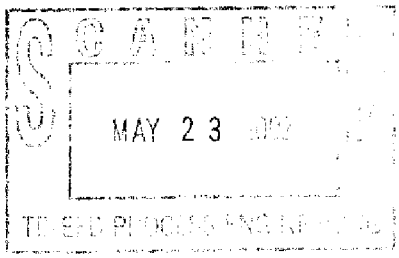
Specification No.: 5520-FM-318902
February 1, 2002
Rev. K

Traveler Title:	Specification No:	Revision:	DR No:
LHC End Can Installation Traveler	5520-TR-333496	A	HGQ-0275

Step No:	Drawing No:	Routing Form No:	Serial No:
8.5			MQXBC-002

Discrepancy Description:

1. Coil to Ground short noted in Quadrant #1.
2. Coil to End Can short noted in Quadrant #3.



Originator: Damon Bice

Date: 11/14/01

Cause of Nonconformance:

The Hipot after the end can was reinstalled (reference DR No. HGQ-0274) showed that the short between heater and outer coil was fixed, but two more shorts now were evident. One was a 1/8 coil tap pinched between the collet and end can. Would have been easy to fix, but there was another, unrelated, and much more serious failure. A coil-to-ground short in Q1, failed at about 200 volts, and became a dead resistive short. Not related to the heaters or any taps. Electrical measurements showed it to be as close as could be measured to the end of the collar laminations. We took the end can off again, and Jim Rife broke the first lamination in Q1 free. The short immediately went away, confirming that it is another one of the lamination to coil shorts at the end of the magnet. We now have had this same Hipot failure in P1, MQXB01, and MQXB02, where the last, or nearly last, collar lamination has cut through the ground wrap at the pole corner where the outer coil azimuthal and radial surfaces intersect.

There are two issues, of course:

Responsible Authority: Rodger Bossert

Date: 11/14/01

TD / Engineering Fabrication

Specification No.: 5520-FM-318902
February 1, 2002
Rev. K

Disposition:

1.) What to do with this magnet. For this magnet, there are basically two options. We can either de-key the first three packs (one key length), put in ground wrap patches were necessary, and re-key the ends (following the same formula we used on MQXB01). Or we can just take the whole magnet apart, down to the coils, and redo the whole thing. Jim Rife tells me the second option would take 3 weeks to get back to where we are now. Jim believes we might need a complete teardown, since we already have so many patches in this magnet, and that this will be the fourth, (yes, fourth), time we have installed this collar pack on the same ground wrap. In either case, we still have to re-hang it, and take off the first pack. It is now Thursday morning, so they will probably get it hung, and the first pack off by the end of the day. We will look at it Friday, to see if the answer if obvious. If we think it should be torn down completely, we will not start until you return Monday. Magnet was eventually re-hung, two Collar Keys were removed and a repair was done as was done on MQXB01.

Responsible Authority: Rodger Bossert

Date: 11/14/01

Corrective Action to Prevent Recurrence:

We will modify the last collar pack by "rounding the corners" as in Drawing No. MC-369830.

Responsible Authority: Rodger Bossert

Date: 11/14/01

Corrective Action/Disposition Verified By: Rodger Bossert

Date: 4/5/02

Will Configuration be affected?: ☒ YES ☒ NO

Identified problem area:

☐ Material ☐ Manpower ☐ Method ☐ Machine ☑ Measurement

Reviewed By: Bob Jensen

Date: 5/22/02

The hipot after the end can was reinstalled (reference DR 0274) showed that the short between heater and outer coil was fixed, but two more shorts now were evident. One was a 1/8 coil tap pinched between the collet and end can. Would have been easy to fix, but there was another, unrelated, and much more serious failure. A coil-to-ground short in Q1, failed at about 200 volts, and became a dead resistive short. Not related to the heaters or any taps. Electrical measurements showed it to be as close as could be measured to the end of the collar laminations. We took the end can off again, and Jim Rife broke the first lamination in Q1 free. The short immediately went away, confirming that it is another one of the lamination to coil shorts at the end of the magnet. We now have had this same hipot failure in P1, MQXB01, and MQXB02, where the last, or nearly last, collar lamination has cut through the ground wrap at the pole corner where the outer coil azimuthal and radial surfaces intersect.

There are two issues, of course:

1.) What to do with this magnet. (Disposition)

For this magnet, there are basically two options. We can either dekey the first three packs (one key length), put in ground wrap patches were necessary, and rekey the ends (following the same formula we used on MQXB01). Or we can just take the whole magnet apart, down to the coils, and redo the whole thing. Jim Rife tells me the second option would take 3 weeks to get back to where we are now. Jim believes we might need a complete teardown, since we already have so many patches in this magnet, and that this will be the fourth, (yes, fourth), time we have installed this collar pack on the same ground wrap. In either case, we still have to rehang it, and take off the first pack. It is now Thursday morning, so they will probably get it hung, and the first pack off by the end of the day. We will look at it Friday, to see if the answer if obvious. If we think it should be torn down completely, we will not start until you return Monday.

2) Cause of the problem and long-term solution for future magnets.

There is a root cause, and a couple of contributing factors. The main problem, in my opinion, is a design flaw in the collar lamination configuration. As you know, there are two different sizes of collar lams, stacked intermittently into packs. There is a small, unsupported gap where there is clearance between the small lamination of one quadrant and the large one from the adjacent quadrant. This gap is, unfortunately, placed at the corner where the azimuthal pole and outer radial surfaces of the outer coil intersect, a place where it is easy to "pinch" the insulation if it is bunched slightly in that area. Other magnets (SSC Dipole, for example), had similar gaps, but they were placed farther down on the radial surface. Also, on our MQXB's, the radius on the "large" lamination is very small, leaving the pinched ground wrap nowhere to go, so it is easily be severed.

There are several other factors that make the situation worse. Due to the fact that we added the 8 mil thick strip heater outside the outer coil late in the program, two layers of ground wrap (one 5 mil and one 3 mil) were "split" at that corner, leaving us with only two, 5 mil layers of ground wrap covering that point (we knew that, but thought it would be enough). Also, on the long coils, for P1 and MQXB01, our assembly mandrel did not have holes near the end, causing the ground wrap to not be seated well at the ends before collaring, resulting in "bunching", and exacerbating the problem near the ends. The final factor, also only affecting P1 and MQXB01, was that we failed to "round" the corners of the face of the last lamination before collaring. Both the collar

4.0 Return End - End Can Installation

4.1 Slide the Tapered Ring-Return End (ME-369031) using a Mylar sleeve, onto the Collared Coil.

Technician(s) 11-21-01 Date

4.2 Bolt the (2) Pusher Plates (MC-369169) with 0.50 inch-13UNC x 13.0 inch Socket Head Cap Screws and 0.50 inch Flat Washers, onto the End Squeezer Assembly (ME-344350).

Note(s):

Pusher Plates must be installed with hydraulic cylinder sides facing towards center of Coil as not to interfere with any wiring involved in Lead End Assembly.

Technician(s) 11-21-01 Date

4.3 Install the Kapton and the Filler Cone (MC-344457) atop the Saddles with Plastic Cable ties.

Caution:

Ensure dry lubricant coating remains intact and free of damage.

Record the amount of Kapton used:

.003

Technician(s) 11-21-01 Date

4.4 Slide the Tapered Ring-Return End (ME-369031) on the Filler Cone-Return End (ME-369030) as per the Collared Coil with Ends (ME-369580).

Note(s):

Top of the Tapered Ring and the top of the Collared Coil match.
Strain Gage wires are on the outside of the Aluminum Tapered Ring.
Voltage Tap Wires are extended through the inside of the Aluminum Tapered Ring.

Technician(s) 11-21-01 Date

4.5 Position the Holder Plate with the installed Half Rings (MC-344359), until it contacts the back surface of the Filler Cone (ME-369030).

Technician(s) 11-21-01 Date

4.6 Attach the Enerpac Hose to Hydraulic Cylinders (Model RC 106) as per the End Squeezer Assembly (ME-344350).

Note(s):

Face shield must be worn during operation of hydraulic cylinders.

Technician(s) 11-21-01 Date

4.7 Record Total Coil Starting Resistance 2.307 Ω.

Technician 11-21-01 Date

4.8 Gradually apply pressure to the End Squeezer Assembly until the Aluminum Tapered Ring covers the Filler Cone. Maximum pump pressure is to be greater than 4000psi.

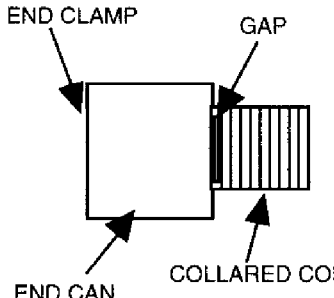
Maximum Pump Pressure 3600

Technician(s) 11-21-01 Date

4.9 Record Total Coil End Resistance 2.308 Ω

Technician 11-21-01 Date

4.10 Before removing the End Squeezer Assembly, measure the gap between the Filler Cone and the Coil Lamination, as shown below, using a Micrometer.



Gap Measurement Quad 1 .020

Gap Measurement Quad 2 .010

Gap Measurement Quad 3 .020

Gap Measurement Quad 4 .022

Technician(s) 11-21-01 Date

STOP

4.11 Verify that the results in Step 4.10 are acceptable.
Approved for next Assembly Procedure.

Responsible Authority/Physicist 11-21-01 Date

4.12 Remove the End Squeezer Assembly.

Technician(s) 11-21-01 Date

5.0 Return End Can Inspection

TRR# 1298

5.1 Perform a Pi tape measurement on the Tapered Ring at the following locations.

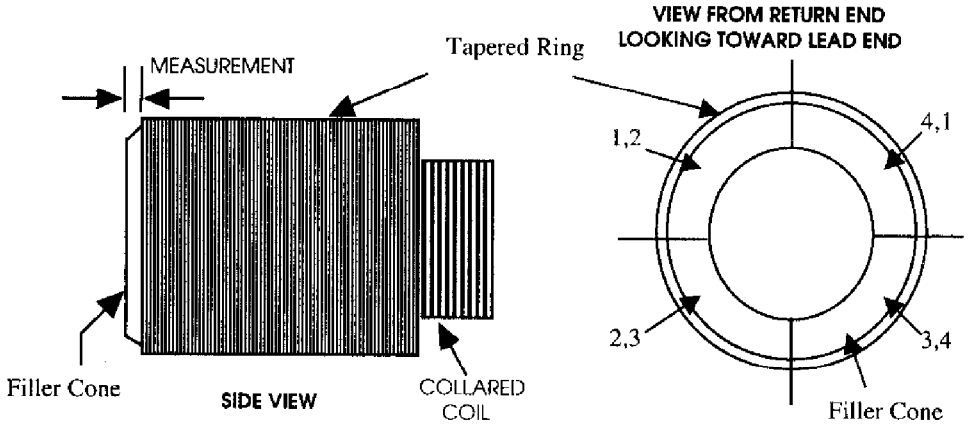
Distance from the Coil End of the Tapered Ring (A)	Pi Tape
0.0 inches	
1.0 inches	
2.0 inches	
3.0 inches	
4.0 inches	
5.0 inches	

N/A
Technician(s) Date

5.2 Clean the Filler Cone using Isopropyl Alcohol (Fermi stock 1920-0300) Kimwipes (Fermi stock 1660-2600) or equivalent.

Technician(s) 11-21-01
Date

5.3 Measure the distance between each Filler Cone and the Tapered Ring, using a Depth Gauge.

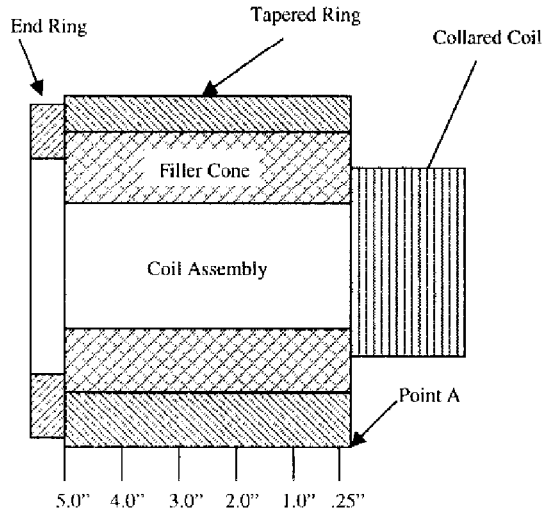


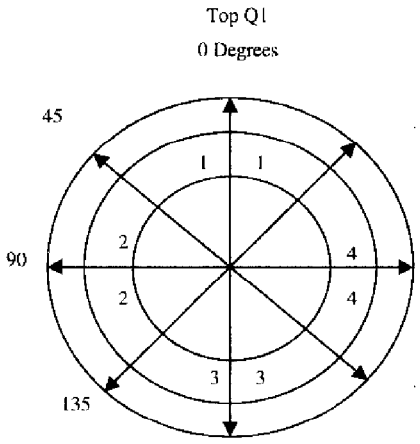
Filler Cone 1,2	.002
Filler Cone 2,3	.003
Filler Cone 3,4	.001
Filler Cone 1,4	.002
AVERAGE	.002

Technician(s) 11-21-01
Date

5.4 Measure the diameter of the Tapered Ring (MC-344456) in the fully clamped state, at 0, 45, 90 and 135 Degrees at 1" intervals using a 9"-10" Micrometer and PI Tape.

View from the Return End looking toward the Lead End





Distance from the Coil End of the Tapered Ring (A)	0 Degree	45 Degree	90 Degree	135 Degree	Pi Tape
0.0 inches	9.8575	9.849	9.852	9.850	9.851
1.0 inches	9.852	9.849	9.853	9.849	9.852
2.0 inches	9.851	9.849	9.852	9.849	9.852
3.0 inches	9.851	9.848	9.850	9.848	9.851
4.0 inches	9.850	9.848	9.850	9.847	9.852
5.0 inches	9.850	9.849	9.852	9.847	9.851

Technician(s)

11-26-01
Date

5.5 Perform an electrical inspection on each of the individual Inner Coils, Outer Coils and Quadrants. Refer to the Valhalla and Leader Free Standing Coil Measurement Procedure (ES-292306), and the Procedure for Electrical Inspection of Voltage Taps (ES-301383).

Note(s):

Ensure that all measurements are recorded correctly, and have the proper value and symbol (i.e., mΩ, mH, etc.).

Valhalla 4300B settings:

Test current	_____	Off (not testing)
Power	_____	On
Full scale voltage	_____	20mv
Amp selector knob	_____	1 A
Temperature compensator	_____	On
Test current	_____	On (testing)

Hp 4263 B:

Function	_____	"Ls-Q" selected

Record the Serial Number of the test equipment used.

Valhalla _____

HP 4263b _____

Resistance		Inner	Outer	Total	Pass	Fail
Nominal		345 mΩ to 390 mΩ	410 mΩ to 455 mΩ	560 to 585 mΩ		
Quadrant 1	Inner	.2568 mΩ				
	Outer		.3192 mΩ			
	Total			.5759 mΩ		
Quadrant 2	Inner	.2576 mΩ				
	Outer		.3189 mΩ			
	Total			.5764 mΩ		
Quadrant 3	Inner	.2577 mΩ				
	Outer		.3181 mΩ			
	Total			.5757 mΩ		
Quadrant 4	Inner	.2574 mΩ				
	Outer		.3187 mΩ			
	Total			.5759 mΩ		
Total Magnet		Nominal	2.3 Ω	2.305 Ω		

Perform a Hipot on the Collared Coil Assembly (**Maximum Leakage 2.5μA**)

5 KV	Measurement(s)
Heater #1/2 to Ground	
Heater #2/3 to Ground	
Heater #3/4 to Ground	
Heater #4/1 to Ground	
Heater #1/2 to All 4 Quadrants	
Heater #2/3 to All 4 Quadrants	
Heater #3/4 to All 4 Quadrants	
Heater #4/1 to All 4 Quadrants	
All 4 Quadrants to Ground	

COIL TO COIL 3.0 KV	Measurement(s)
Quadrant 1 to Quadrant 2	
Quadrant 2 to Quadrant 3	
Quadrant 3 to Quadrant 4	
Quadrant 4 to Quadrant 1	

N/A

Inspector _____ Date _____

STOP

5.6 Verify that the results in Step 5.5 are acceptable.
Approved for next Assembly Procedure.

Responsible Authority/Physicist — Date: 11-29-01

5.7 Thread the Voltage Taps, and Heater Strips through the openings of the End Can End Ring (MB-344533).

Technician(s) — Date: 11-29-01

5.8 Place the End Can End Ring (MB-344533) onto the Tapered Ring (MC-344456).

Technician(s) — Date: 11-29-01

TRR# 1292

5.9 Remove the old Strain Gage Wire RTV from the top and bottom instrumentation slots of the Collared Coil at both Return and Lead ends (only from areas where Strain Gage Wires had originally been "peeled back"). Re-apply Silicone Rubber Primer (Fermi-Stock 1940-1300) or equivalent onto the instrumentation slots and secure Strain Gage Wires into position with a mixture of RTV (Fermi-Stock 1940-0750) or equivalent.

Technician(s) — Date

7.0 Lead End Can Installation

7.1 Slide the Tapered Ring (MC-344456) using a Mylar sleeve, onto the Collared Coil.

Technician(s) 11-13-01 Date

7.2 Bolt the (2) Pusher Plates (MC-369169) with .50 inch-13UNC x 13.0 inch Socket Head Cap Screws and 1/2" Flat Washers, onto the End Squeezer Assembly (ME-344350).

Note(s):

Pusher Plates must be installed with hydraulic cylinder sides facing towards center of the Coil as not to interfere with any wiring involved in the Lead End Assembly.

Technician(s) 11-13-01 Date

7.3 Install the Kapton and the Filler Cone (MC-344457) atop the Saddles with Plastic Cable ties.

Caution:

Ensure dry lubricant coating remains intact and free of damage.

Record the amount of Kapton used:

.003

Technician(s) 11-15-01 Date

X 7.4 Slide the Tapered Ring Lead End (ME-344456) on to the Filler Cone Lead End (ME-344457) as per the Collared Coil with Ends (ME-369580).

Note(s):

Top of the Tapered Ring and the top of the Collared Coil match.
Strain Gage wires are on the outside of the Aluminum Tapered Ring.
Voltage Tap Wires are extended through the inside of the Aluminum Tapered Ring.

Technician(s) _____ Date 11-13-01

7.5 Position the Holder Plate with the installed Half Rings (MC-344359), until it contacts the back surface of the Filler Cone (ME-344457).

Technician(s) _____ Date 11-13-01

7.6 Attach the Enerpac Hose to the Hydraulic Cylinders (Model RC 106) as per the Collared Coil End Squeezer Assembly (ME-344350).

Note(s):

Face shield must be worn during operation of hydraulic cylinders.

Technician(s) _____ Date 11-13-01

7.7 Record Total Coil Starting Resistance 2.303 Ω.

Technician _____ Date 11-13-01

7.8 Gradually apply pressure to the End Squeezer Assembly until the Aluminum Tapered Ring covers the Filler Cone. Maximum Pump pressure is to be greater than 4000psi.

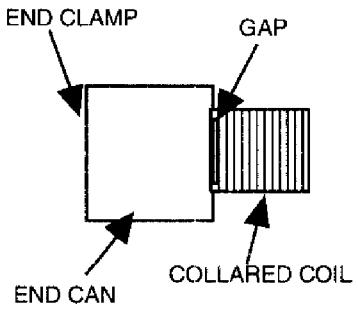
Maximum Pump Pressure 8200 PSI

Technician(s) _____ Date 11-13-01

7.9 Record Total Coil End Resistance 2.305 Ω

Technician _____ Date 11-15-01

7.10 Before removing the End Squeezer Assembly, measure the gap between the Filler Cone and the Coil Lamination, as shown below, using a Micrometer. The gap should be no more than 10 mils.



TR# TO CHANGE LIMITS 1/4.22

Gap Measurement Quad 1 .015

Gap Measurement Quad 2 .016

Gap Measurement Quad 3 .012

Gap Measurement Quad 4 .005

Technician(s) _____ Date 11/13/01

STOP

7.11 Verify that the results in Step 7.10 are acceptable.
Approved for next Assembly Procedure.

Responsible Authority/Physicist _____ Date 11-13-01

7.12 Remove the entire End Squeezer Assembly.

Technician(s) _____ Date 11-13-01

8.0 Lead End Can Inspection

8.1 Perform a Pi tape measurement on the Tapered Ring at the following locations.

TRR# 1298

Distance from the Coil End of the Tapered Ring (**A**)	Pi Tape
0.0 inches	
1.0 inches	
2.0 inches	
3.0 inches	
4.0 inches	
5.0 inches	

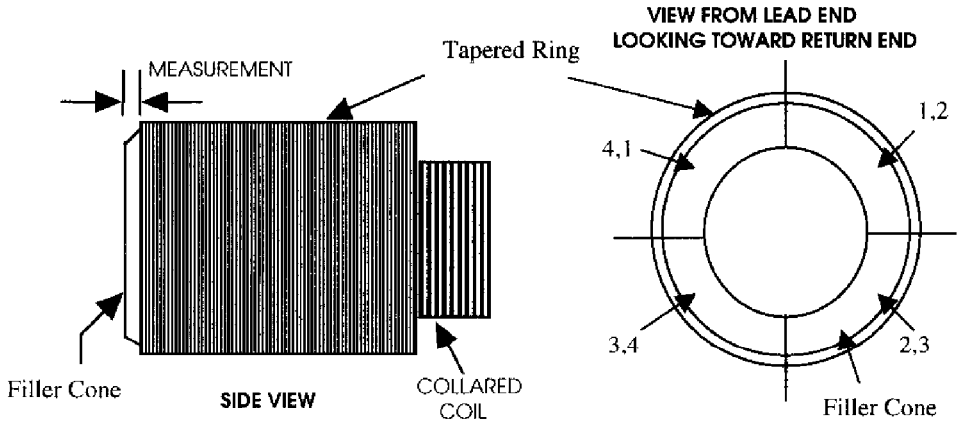
N/A

Technician(s) Date

8.2 Clean the Filler Cone using Isopropyl Alcohol (Fermi stock 1920-0300) and Kimwipes (Fermi stock 1660-2600) or equivalent.

Technician(s) 11-13-01
Date

8.3 Measure the distance between each Filler Cone and the Tapered Ring, using a Depth Gauge.

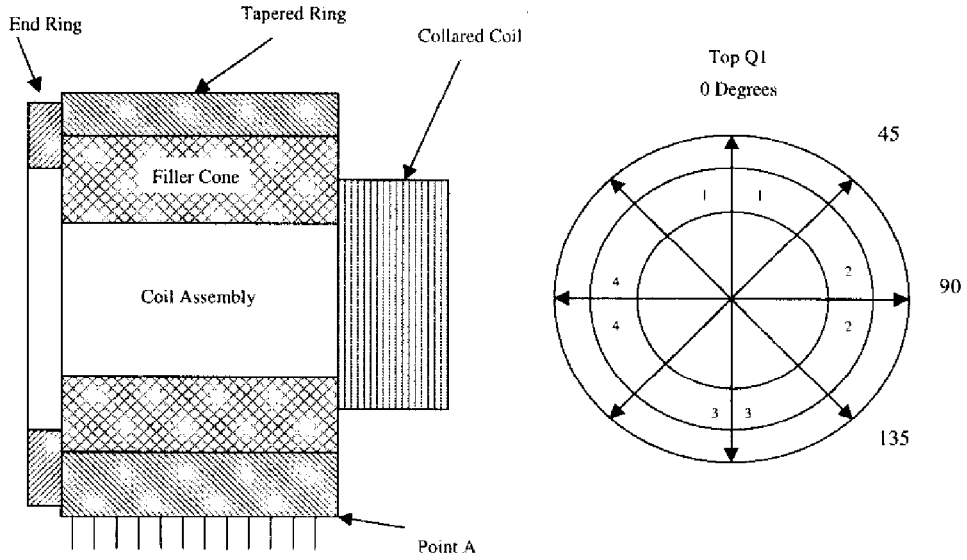


Filler Cone 1,2	.011
Filler Cone 2,3	.009
Filler Cone 3,4	.012
Filler Cone 1,4	.013
AVERAGE	.01125

Technician(s) 11/13/01
Date

8.4 Measure the diameter of the Tapered Ring (MC-344456) in the fully clamped state, at the 0, 45, 90 and 135 Degrees at 1" intervals using a 9"-10" Micrometer and PI Tape.

Looking from the Lead End to the Return End



Distance from the Coil End of the Tapered Ring (A)	0 Degrees	45 Degree	90 Degree	135 Degree	Pi Tape
0.00 inches	9.851	9.852	9.851	9.851	9.854
1.00 inches	9.851	9.852	9.8515	9.851	9.853
2.00 inches	9.852	9.852	9.852	9.851	9.854
3.00 inches	9.852	9.853	9.852	9.8515	9.854
4.00 inches	9.852	9.853	9.852	9.852	9.854
5.00 inches	9.8525	9.853	9.8515	9.852	9.854
6.00 inches	9.8525	9.853	9.851	9.851	9.854
7.00 inches	9.853	9.853	9.8505	9.851	9.853
8.00 inches	9.853	9.852	9.850	9.851	9.852
9.00 inches	9.853	9.853	9.849	9.851	9.853
9.50 inches	9.853	9.8535	9.849	9.8515	9.853

Technician(s)

11-15-01
Date

8.5 Perform an electrical inspection on each of the individual Inner Coils, Outer Coils and Quadrants. Refer to the Valhalla and Leader Free Standing Coil Measurement Procedure (ES-292306), and the Procedure for Electrical Inspection of Voltage Taps (ES-301383).

Note(s):

Ensure that all measurements are recorded correctly, and have the proper value and symbol (i.e., mΩ, mH, etc.).

Valhalla 4300B settings:

Test current	_____	Off (not testing)
Power	_____	On
Full scale voltage	_____	20mv
Amp selector knob	_____	1 A
Temperature compensator	_____	On
Test current	_____	On (testing)

Hp 4263 B:

Function	_____	"Ls-Q" selected

Record the Serial Number of the test equipment used.

Valhalla 32-858

HP 4263b 2848J00912

Resistance		Inner	Outer	Total	Pass	Fail
Nominal		345 mΩ to 390 mΩ	410 mΩ to 455 mΩ	560 to 585 mΩ		
Quadrant 1	Inner	.2564 mΩ				
	Outer		.3185 mΩ			
	Total			.5749 mΩ		
Quadrant 2	Inner	.2571 mΩ				
	Outer		.3183 mΩ			
	Total			.5754 mΩ		
Quadrant 3	Inner	.2574 mΩ				
	Outer		.3174 mΩ			
	Total			.5747 mΩ		
Quadrant 4	Inner	.2571 mΩ				
	Outer		.3184 mΩ			
	Total			.5754 mΩ		
Total Magnet		Nominal	2.3 Ω	2.299 Ω		

Inductance		Inner	Outer	Total	Pass	Fail
Nominal		620-650 µH	1.120 to 1.17 mH	2.880 to 2.935 mH		
Quadrant 1	Inner	727.982 µH				
	Outer		1.27101 mH			
	Total			2.31967 mH		
Quadrant 2	Inner	917.007 µH				
	Outer		1.25307 mH			
	Total			2.32322 mH		
Quadrant 3	Inner	811.500 µH				
	Outer		1.21001 mH			
	Total			2.32263 mH		
Quadrant 4	Inner	920,220 µH				
	Outer		1.25897 mH			
	Total			2.32762 mH		
Total Magnet		Nominal	17 mH	13.3536 mH		

Q-Factor		Inner	Outer	Total	Pass	Fail
Nominal		3.0 to 3.5	4.3 to 5.0	4.5 to 5.2		
Quadrant 1	Inner	2.04				
	Outer		2.24			
	Total			5.32		
Quadrant 2	Inner	1.99				
	Outer		2.19			
	Total			5.31		
Quadrant 3	Inner	1.79				
	Outer		2.02			
	Total			5.35		
Quadrant 4	Inner	2.08				
	Outer		2.24			
	Total			5.34		
Total Magnet		Nominal	4.3	5.95		

Inspector

11-15-01
Date

Electrical Test	Limit	Actual Measurement	Pass	Fail
Heater Strips 1/2 Resistance	9.20 to 9.60 Ω	9.209 Ω		
Heater Strips 2/3 Resistance	9.20 to 9.60 Ω	9.193 Ω		
Heater Strips 3/4 Resistance	9.20 to 9.60 Ω	9.241 Ω		
Heater Strips 4/1 Resistance	9.20 to 9.60 Ω	9.178 Ω		

Inspector

11-17-01
Date

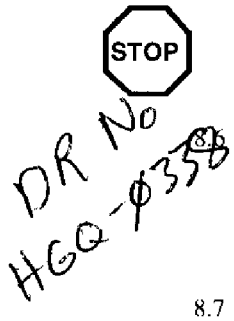
Perform a Hipot on the Collared Coil Assembly (**Maximum Leakage 2.5μA**)

5 KV	Measurement(s)
Heater #1/2 to Ground	1 μA
Heater #2/3 to Ground	1 μA
Heater #3/4 to Ground	1 μA
Heater #4/1 to Ground	1 μA
Heater #1/2 to All 4 Quadrants	1 μA
Heater #2/3 to All 4 Quadrants	1 μA
Heater #3/4 to All 4 Quadrants	1 μA
Heater #4/1 to All 4 Quadrants	1 μA
All 4 Quadrants to Ground	1 μA

COIL TO COIL 3.0 KV	Measurement(s)
Quadrant 1 to Quadrant 2	
Quadrant 2 to Quadrant 3	.05
Quadrant 3 to Quadrant 4	.05
Quadrant 4 to Quadrant 1	.05

Inspector

11-21-01
Date



8.6 Verify that the results in Step 8.5 are acceptable.
Approved for next Assembly Procedure.

_____ _____
Responsible Authority/Physicist Date

8.7 Thread the Coil Leads, Voltage Taps and Heater Strips through the openings of the End Can End Ring (MB-344533).

_____ _____
Technician(s) Date

8.8 Place the End Can End Ring (MB-344533) onto the Tapered Ring (MC-344456).

_____ _____
Technician(s) Date

8.9 Remove the old Strain Gage Wire RTV from the top and bottom instrumentation slots of the collared coil at both return and lead ends (only from areas where Strain Gage Wires had originally been "peeled back"). Re-apply Silicone Rubber Primer (Fermi stock 1940-1300) or equivalent onto the instrumentation slots and secure Strain Gage Wires into position with a mixture of RTV (Fermi stock 1940-0750) or equivalent.

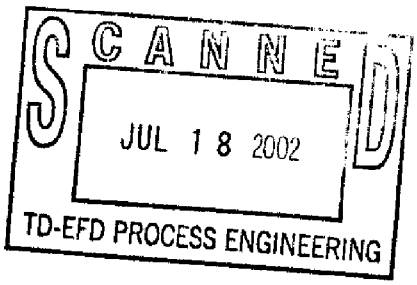
_____ _____
Technician(s) Date

Traveler Title:	Specification No:	Revision:	DR No:
LHC End Can Installation Traveler	5520-TR-333496	A	HGQ-0338

Step No:	Drawing No:	Routing Form No:	Serial No:
8.5	ME-369580		MQXBC-002-1

Discrepancy Description:

The Inner Coil Leads dropped into the Bore.



Originator: John Szostak

Date: 5/24/2002

Cause of Nonconformance:

There was nothing to prevent the Inner Coil Leads from dropping into the Bore.

Responsible Authority: John Szostak

Date: 5/24/2002

Disposition:

Re-install collet using soft spherical fixture (UMLB-2002) or equivalent. (Re-issue 333496 Step 7.1 to 8.9 - John Szostak - 5/24/02)

Responsible Authority: Rodger Bossert

Date: 5/24/2002

Corrective Action to Prevent Recurrence:

Add step to traveler to include soft spherical fixture (UMLB-2002) or equivalent. (TRR No. 1471) (Received by Process Engineering on 6/5/02 - John Szostak)

Responsible Authority: Rodger Bossert

Date: 5/24/2002

Corrective Action/Disposition Verified By: John Szostak

Date: 7/9/2002

Will Configuration be affected?: ☐ YES ☑ NO

Identified problem area:

☐ Material ☐ Manpower ☑ Method ☐ Machine ☐ Measurement

Reviewed By: Bob Jensen

Date: 7/10/2002

7.0 Lead End Can Installation

7.1 Slide the Tapered Ring (MC-344456) using a Mylar sleeve, onto the Collared Coil.

Technician(s) 11-29-01 Date

7.2 Bolt the (2) Pusher Plates (MC-369169) with .50 inch-13UNC x 13.0 inch Socket Head Cap Screws and 1/2" Flat Washers, onto the End Squeezer Assembly (ME-344350).

Note(s):

Pusher Plates must be installed with hydraulic cylinder sides facing towards center of the Coil as not to interfere with any wiring involved in the Lead End Assembly.

Technician(s) 11-29-01 Date

7.3 Install the Kapton and the Filler Cone (MC-344457) atop the Saddles with Plastic Cable ties.

Caution:

Ensure dry lubricant coating remains intact and free of damage.

Record the amount of Kapton used:

1003

Technician(s) 11-29-01 Date

X 7.4 Slide the Tapered Ring Lead End (ME-344456) on to the Filler Cone Lead End (ME-344457) as per the Collared Coil with Ends (ME-369580).

Note(s):

Top of the Tapered Ring and the top of the Collared Coil match.
Strain Gage wires are on the outside of the Aluminum Tapered Ring.
Voltage Tap Wires are extended through the inside of the Aluminum Tapered Ring.

Technician(s) _____ Date 11-29-01

7.5 Position the Holder Plate with the installed Half Rings (MC-344359), until it contacts the back surface of the Filler Cone (ME-344457).

Technician(s) _____ Date 11/29/01

7.6 Attach the Enerpac Hose to the Hydraulic Cylinders (Model RC 106) as per the Collared Coil End Squeezer Assembly (ME-344350).

Note(s):

Face shield must be worn during operation of hydraulic cylinders.

Technician(s) _____ Date 11-29-01

7.7 Record Total Coil Starting Resistance 2.308 Ω.

Technician _____ Date 11-29-01

7.8 Gradually apply pressure to the End Squeezer Assembly until the Aluminum Tapered Ring covers the Filler Cone. Maximum Pump pressure is to be greater than 4000psi.

Maximum Pump Pressure 7000

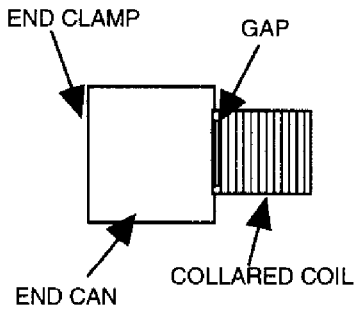
Technician(s) _____ Date _____

7.9 Record Total Coil End Resistance 2.308 Ω

Technician _____ Date 11-29-01

7.10 Before removing the End Squeezer Assembly, measure the gap between the Filler Cone and the Coil Lamination, as shown below, using a Micrometer. The gap should be no more than 10 mils.

TRR# 1422



Gap Measurement Quad 1 .020

Gap Measurement Quad 2 .025

Gap Measurement Quad 3 .022

Gap Measurement Quad 4 .027

Technician(s) 11/29/01 Date

STOP

7.11 Verify that the results in Step 7.10 are acceptable.
Approved for next Assembly Procedure.

Responsible Authority/Physicist 11-29-01 Date

7.12 Remove the entire End Squeezer Assembly.

Technician(s) 11-29-01 Date

8.0 Lead End Can Inspection

8.1 Perform a Pi tape measurement on the Tapered Ring at the following locations.

TRR# 1298

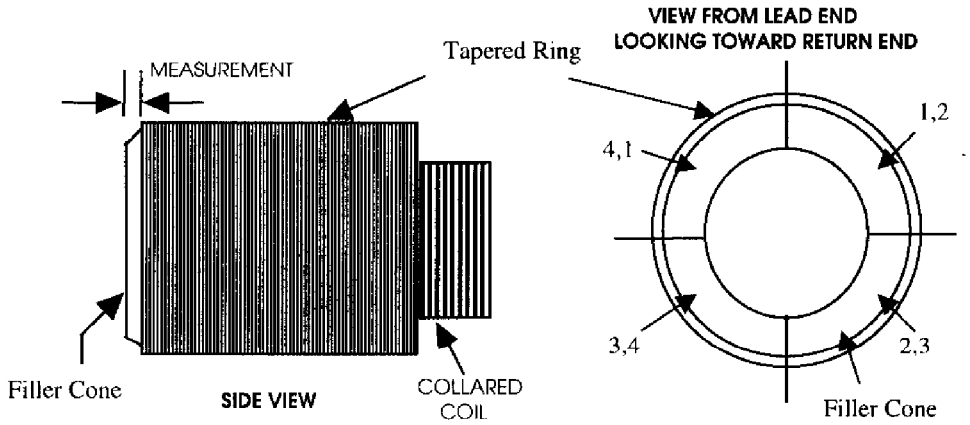
Distance from the Coil End of the Tapered Ring (A)	Pi Tape
0.0 inches	
1.0 inches	
2.0 inches	
3.0 inches	
4.0 inches	
5.0 inches	

N/A
Technician(s) Date

8.2 Clean the Filler Cone using Isopropyl Alcohol (Fermi stock 1920-0300) and Kimwipes (Fermi stock 1660-2600) or equivalent.

Technician(s) 11/29/01
Date

8.3 Measure the distance between each Filler Cone and the Tapered Ring, using a Depth Gauge.

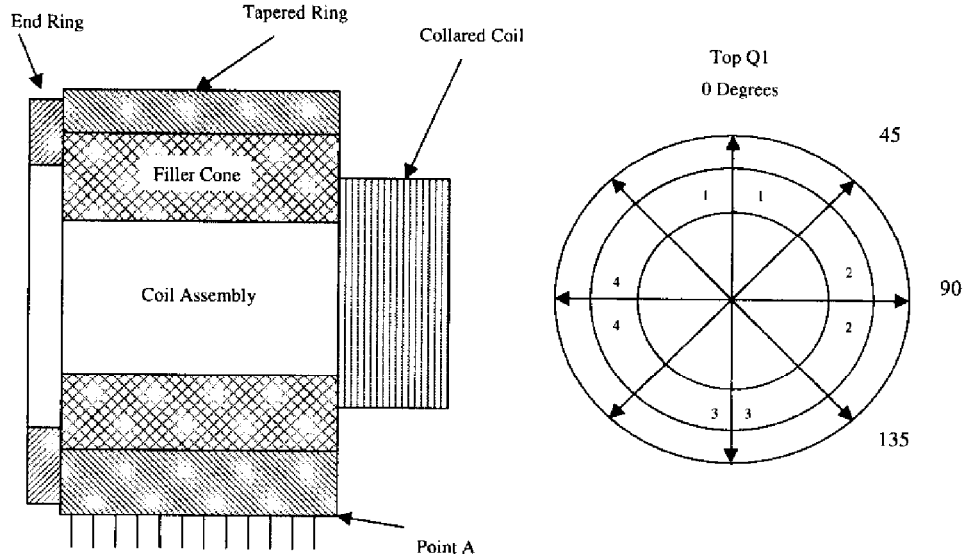


Filler Cone 1,2	.014
Filler Cone 2,3	.018
Filler Cone 3,4	.023
Filler Cone 1,4	.020
AVERAGE	.0195

Technician(s) 11/29/01
Date

8.4 Measure the diameter of the Tapered Ring (MC-344456) in the fully clamped state, at the 0, 45, 90 and 135 Degrees at 1" intervals using a 9"-10" Micrometer and PI Tape.

Looking from the Lead End to the Return End



Distance from the Coil End of the Tapered Ring (A)	0 Degrees	45 Degree	90 Degree	135 Degree	Pi Tape
0.00 inches	9.8495	9.850	9.850	9.852	9.851
1.00 inches	9.849	9.851	9.851	9.849	9.851
2.00 inches	9.852	9.851	9.852	9.851	9.851
3.00 inches	9.8495	9.852	9.852	9.8505	9.850
4.00 inches	9.852	9.852	9.852	9.851	9.851
5.00 inches	9.849	9.852	9.852	9.8515	9.851
6.00 inches	9.850	9.8515	9.8515	9.8505	9.851
7.00 inches	9.850	9.8515	9.8515	9.8505	9.851
8.00 inches	9.852	9.852	9.851	9.850	9.851
9.00 inches	9.850	9.852	9.851	9.849	9.851
9.50 inches	9.850	9.8505	9.8505	9.8505	9.851

Technician(s)

11-29-01
Date

8.5 Perform an electrical inspection on each of the individual Inner Coils, Outer Coils and Quadrants. Refer to the Valhalla and Leader Free Standing Coil Measurement Procedure

TD/Engineering & Fabrication

Specification # 5520-TR-333496
September 28, 2001
Rev. A

Q-Factor		Inner	Outer	Total	Pass	Fail
Nominal		3.0 to 3.5	4.3 to 5.0	4.5 to 5.2		
Quadrant 1	Inner	2.01				
	Outer		2.18			
	Total			5.33		
Quadrant 2	Inner	2.03				
	Outer		2.17			
	Total			5.32		
Quadrant 3	Inner	1.88				
	Outer		2.11			
	Total			5.37		
Quadrant 4	Inner	1.86				
	Outer		2.10			
	Total			5.36		
Total Magnet		Nominal	4.3	5.96		

Inspector

11-29-01
Date

Electrical Test	Limit	Actual Measurement	Pass	Fail
Heater Strips 1/2 Resistance	9.20 to 9.60 Ω	9.308 Ω	✓	
Heater Strips 2/3 Resistance	9.20 to 9.60 Ω	9.285 Ω	✓	
Heater Strips 3/4 Resistance	9.20 to 9.60 Ω	~~9.476~~ 9.342 Ω		
Heater Strips 4/1 Resistance	9.20 to 9.60 Ω	9.476 Ω		

Inspector

11-29-01
Date

Perform a Hipot on the Collared Coil Assembly (**Maximum Leakage 2.5μA**)

DR # HGQ 0282

5 KV	Measurement(s)
Heater #1/2 to Ground	2.8 μA
Heater #2/3 to Ground	2.8 μA
Heater #3/4 to Ground	2.8 μA
Heater #4/1 to Ground	2.8 μA
Heater #1/2 to All 4 Quadrants	
Heater #2/3 to All 4 Quadrants	
Heater #3/4 to All 4 Quadrants	
Heater #4/1 to All 4 Quadrants	
All 4 Quadrants to Ground	2.25 μA

failed @ 4.0 KV
DR HGQ 0283

COIL TO COIL 3.0 KV	Measurement(s)
Quadrant 1 to Quadrant 2	.05 μA
Quadrant 2 to Quadrant 3	.05 μA
Quadrant 3 to Quadrant 4	.4 μA
Quadrant 4 to Quadrant 1	.6 μA

Inspector

11-30-01
Date

8.6 Verify that the results in Step 8.5 are acceptable.
Approved for next Assembly Procedure.

_____ _____
Responsible Authority/Physicist Date

8.7 Thread the Coil Leads, Voltage Taps and Heater Strips through the openings of the End Can End Ring (MB-344533).

_____ _____
Technician(s) Date

8.8 Place the End Can End Ring (MB-344533) onto the Tapered Ring (MC-344456).

_____ _____
Technician(s) Date

8.9 Remove the old Strain Gage Wire RTV from the top and bottom instrumentation slots of the collared coil at both return and lead ends (only from areas where Strain Gage Wires had originally been "peeled back"). Re-apply Silicone Rubber Primer (Fermi stock 1940-1300) or equivalent onto the instrumentation slots and secure Strain Gage Wires into position with a mixture of RTV (Fermi stock 1940-0750) or equivalent.

_____ _____
Technician(s) Date

Traveler Title:	Specification No:	Revision:	DR No:
LHC End Can Installation Traveler	5520-TR-333496	A	HGQ-0282

Step No:	Drawing No:	Routing Form No:	Serial No:
8.5	ME-369580		MQXBC-002-2

Discrepancy Description:

Leakage of heater to ground is above acceptable leakage requirements.

Originator: Damon Bice

Date: 11/30/2001

Cause of Nonconformance:

High Leakage was caused by Coil shorts to ground.

Responsible Authority: Rodger Bossert

Date: 11/30/2001

Disposition:

Magnet was disassembled due to coil-ground short. Leakage was normal upon re-assembly.

Responsible Authority: Rodger Bossert

Date: 1/20/2002

Corrective Action to Prevent Recurrence:

Traveler Procedure for Hipotting needs to be changed so that Heaters are grounded during Coil-Ground Hipot and Coil is grounded during Heater-Ground Hipot. (TRR No. 1254 - John Szostak 1/20/02)

Responsible Authority: Rodger Bossert

Date: 2/8/2002

Corrective Action/Disposition Verified By: Rodger Bossert

Date: 1/20/2002

Will Configuration be affected?: ☐ YES ☑ NO

Identified problem area:

☐ Material ☐ Manpower ☐ Method ☐ Machine ☑ Measurement

Reviewed By: Bob Jensen

Date: 2/8/2002

Traveler Title:	Specification No:	Revision:	DR No:
LHC End Can Installation Traveler	5520-TR-333496	A	HGQ-0283

Step No:	Drawing No:	Routing Form No:	Serial No:
8.5	ME-369580		MQXBC-002-2

Discrepancy Description:

Heaters have shorted to coil leads at 4 KV.

Originator: Damon Bice

Date: 11/30/2001

Cause of Nonconformance:

The 1/8 Coil Voltage Tap was shorted to inside surface of End Can.

Responsible Authority: Rodger Bossert

Date: 11/30/2001

Disposition:

Remove Can, repair Voltage Tap wire and re-install. (Re-issue 333496 Steps 7.1 to 8.5 - John Szostak 11/30/01)

Responsible Authority: Rodger Bossert

Date: 11/30/2001

Corrective Action to Prevent Recurrence:

This is the last Magnet that will have 1/8 Coil Taps. This problem will therefore be eliminated on all future magnets. (TRR No. 1247 - John Szostak 11/30/01)

Responsible Authority: Rodger Bossert

Date: 11/30/2001

Corrective Action/Disposition Verified By: Rodger Bossert

Date: 11/30/2001

Will Configuration be affected?: ☐ YES ☑ NO

Identified problem area:

☐ Material ☐ Manpower ☐ Method ☐ Machine ☑ Measurement

Reviewed By: Bob Jensen

Date: 2/8/2002

7.0 Lead End Can Installation

7.1 Slide the Tapered Ring (MC-344456) using a Mylar sleeve, onto the Collared Coil.

Technician(s) 11-30-01 Date

7.2 Bolt the (2) Pusher Plates (MC-369169) with .50 inch-13UNC x 13.0 inch Socket Head Cap Screws and 1/2" Flat Washers, onto the End Squeezer Assembly (ME-344350).

Note(s):

Pusher Plates must be installed with hydraulic cylinder sides facing towards center of the Coil as not to interfere with any wiring involved in the Lead End Assembly.

Technician(s) 11-30-01 Date

7.3 Install the Kapton and the Filler Cone (MC-344457) atop the Saddles with Plastic Cable ties.

Caution:

Ensure dry lubricant coating remains intact and free of damage.

Record the amount of Kapton used:

1003

Technician(s) 11-30-01 Date

X 7.4 Slide the Tapered Ring Lead End (ME-344456) on to the Filler Cone Lead End (ME-344457) as per the Collared Coil with Ends (ME-369580).

Note(s):

Top of the Tapered Ring and the top of the Collared Coil match.
Strain Gage wires are on the outside of the Aluminum Tapered Ring.
Voltage Tap Wires are extended through the inside of the Aluminum Tapered Ring.

Technician(s) _____ Date 11-30-01

7.5 Position the Holder Plate with the installed Half Rings (MC-344359), until it contacts the back surface of the Filler Cone (ME-344457).

Technician(s) _____ Date 11-30-01

7.6 Attach the Enerpac Hose to the Hydraulic Cylinders (Model RC 106) as per the Collared Coil End Squeezer Assembly (ME-344350).

Note(s):

Face shield must be worn during operation of hydraulic cylinders.

Technician(s) _____ Date 11-30-01

7.7 Record Total Coil Starting Resistance 2.323 Ω.

Technician _____ Date 11-30-01

7.8 Gradually apply pressure to the End Squeezer Assembly until the Aluminum Tapered Ring covers the Filler Cone. Maximum Pump pressure is to be greater than 4000psi.

Maximum Pump Pressure 7000

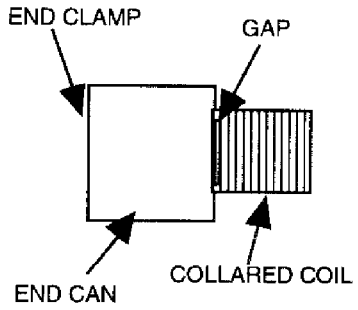
Technician(s) _____ Date 11-30-01

7.9 Record Total Coil End Resistance 3.323 Ω

Technician _____ Date 11-30-01

7.10 Before removing the End Squeezer Assembly, measure the gap between the Filler Cone and the Coil Lamination, as shown below, using a Micrometer. The gap should be no more than 10 mils.

TRR# 1422



Gap Measurement Quad 1 .023

Gap Measurement Quad 2 .030

Gap Measurement Quad 3 .024

Gap Measurement Quad 4 .018

Technician(s) _____ Date 11/30/01

STOP

7.11 Verify that the results in Step 7.10 are acceptable.
Approved for next Assembly Procedure.

Responsible Authority/Physicist _____ Date 11-30-01

7.12 Remove the entire End Squeezer Assembly.

Technician(s) _____ Date 11-30-01

8.0 Lead End Can Inspection

8.1 Perform a Pi tape measurement on the Tapered Ring at the following locations.

TR# 1298

Distance from the Coil End of the Tapered Ring (A)	Pi Tape
0.0 inches	
1.0 inches	
2.0 inches	
3.0 inches	
4.0 inches	
5.0 inches	

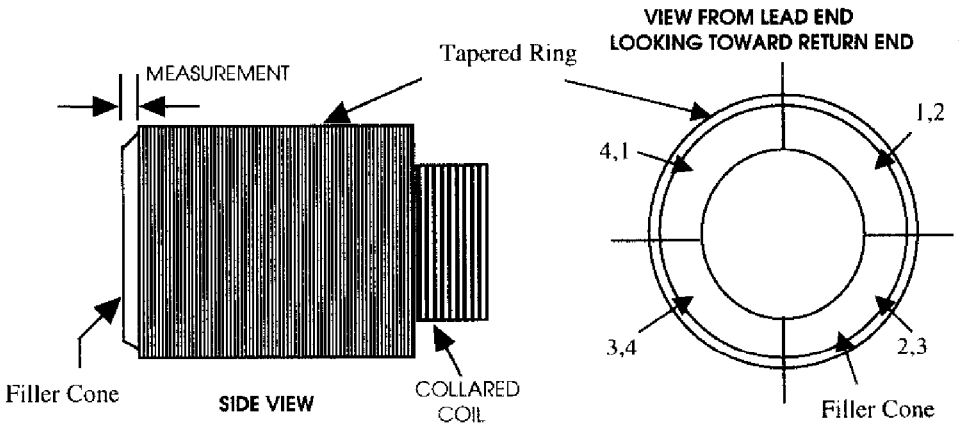
N/A

Technician(s) _____ Date _____

8.2 Clean the Filler Cone using Isopropyl Alcohol (Fermi stock 1920-0300) and Kimwipes (Fermi stock 1660-2600) or equivalent.

Technician(s) _____ Date 11/30/01

8.3 Measure the distance between each Filler Cone and the Tapered Ring, using a Depth Gauge.

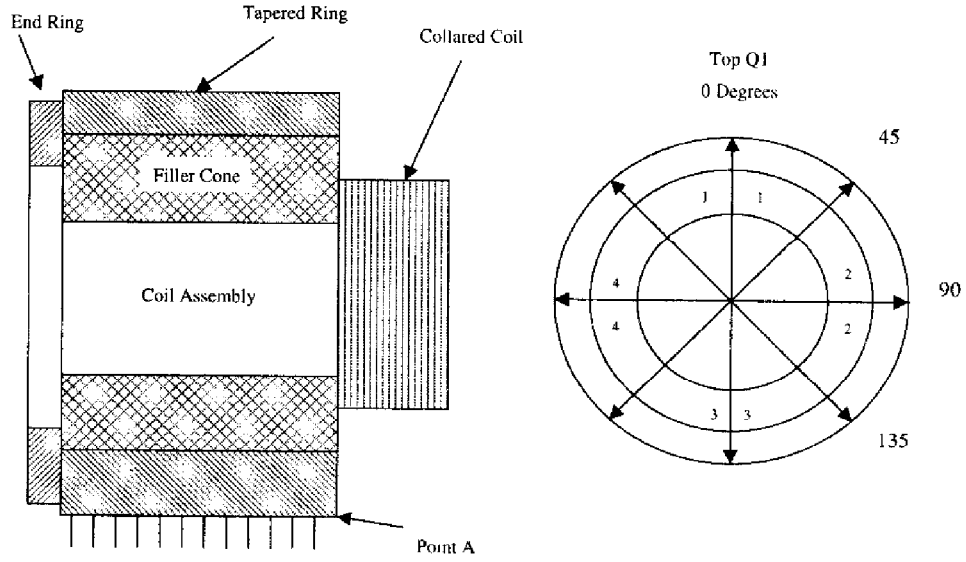


Filler Cone 1,2	.008
Filler Cone 2,3	.007
Filler Cone 3,4	.011
Filler Cone 1,4	.010
AVERAGE	.009

Technician(s) _____ Date 11/30/01

8.4 Measure the diameter of the Tapered Ring (MC-344456) in the fully clamped state, at the 0, 45, 90 and 135 Degrees at 1" intervals using a 9"-10" Micrometer and PI Tape.

Looking from the Lead End to the Return End



Distance from the Coil End of the Tapered Ring (A)	0 Degrees	45 Degree	90 Degree	135 Degree	Pi Tape
0.00 inches	9.849	9.849	9.850	9.8505	9.851
1.00 inches	9.850	9.850	9.851	9.851	9.851
2.00 inches	9.8505	9.851	9.852	9.851	9.851
3.00 inches	9.853	9.852	9.851	9.8515	9.852
4.00 inches	9.849	9.8515	9.852	9.852	9.851
5.00 inches	9.852	9.852	9.851	9.852	9.852
6.00 inches	9.851	9.852	9.850	9.8515	9.851
7.00 inches	9.850	9.851	9.849	9.851	9.852
8.00 inches	9.850	9.849	9.851	9.851	9.851
9.00 inches	9.851	9.851	9.849	9.851	9.851
9.50 inches	9.851	9.850	9.852	9.8515	9.851

Technician(s)

11-30-01
Date

8.5 Perform an electrical inspection on each of the individual Inner Coils, Outer Coils and Quadrants. Refer to the Valhalla and Leader Free Standing Coil Measurement Procedure (ES-292306), and the Procedure for Electrical Inspection of Voltage Taps (ES-301383).

Note(s):

Ensure that all measurements are recorded correctly, and have the proper value and symbol (i.e., mΩ, mH, etc.).

Valhalla 4300B settings:

Test current	_____	Off (not testing)
Power	_____	On
Full scale voltage	_____	20mv
Amp selector knob	_____	1 A
Temperature compensator	_____	On
Test current	_____	On (testing)

Hp 4263 B:

Function	_____	"Ls-Q" selected

Record the Serial Number of the test equipment used.

Valhalla _____

HP 4263b _____

Resistance		Inner	Outer	Total	Pass	Fail
Nominal		345 mΩ to 390 mΩ	410 mΩ to 455 mΩ	560 to 585 mΩ		
Quadrant 1	Inner	2.587 mΩ				
	Outer		3.216 mΩ			
	Total			5.803 mΩ		
Quadrant 2	Inner	2.598 mΩ				
	Outer		3.215 mΩ			
	Total			5.811 mΩ		
Quadrant 3	Inner	2.598 mΩ				
	Outer		3.206 mΩ			
	Total			5.804 mΩ		
Quadrant 4	Inner	2.595 mΩ				
	Outer		3.200 mΩ			
	Total			5.795 mΩ		
Total Magnet		Nominal	2.3 Ω	2.023 Ω		

Inductance		Inner	Outer	Total	Pass	Fail
Nominal		620-650 µH	1.120 to 1.17 mH	2.880 to 2.935 mH		
Quadrant 1	Inner	88 7628 µH				
	Outer		1.22787 mH			
	Total			2.52178 mH		
Quadrant 2	Inner	831.409 µH				
	Outer		1 2224 mH			
	Total			2.52543 mH		
Quadrant 3	Inner	83.794 µH				
	Outer		1 1760 mH			
	Total			2.32401 mH		
Quadrant 4	Inner	780.912 µH				
	Outer		1 105403 mH			
	Total			2 33248 mH		
Total Magnet		Nominal	17 mH	13.9716 mH		

Q-Factor		Inner	Outer	Total	Pass	Fail
Nominal		3.0 to 3.5	4.3 to 5.0	4.5 to 5.2		
Quadrant 1	Inner	2.02				
	Outer		2.23			
	Total			5.32		
Quadrant 2	Inner	2.08				
	Outer		2.26			
	Total			5.42		
Quadrant 3	Inner	1.99				
	Outer		2.20			
	Total			5.27		
Quadrant 4	Inner	1.80				
	Outer		2.05			
	Total			5.35		
Total Magnet		Nominal	4.3	5.96		

T. Price — Inspector

11-30-01 — Date

Electrical Test	Limit	Actual Measurement	Pass	Fail
Heater Strips 1/2 Resistance	9.20 to 9.60 Ω	9.350 Ω		
Heater Strips 2/3 Resistance	9.20 to 9.60 Ω	9.387 Ω		
Heater Strips 3/4 Resistance	9.20 to 9.60 Ω	9.341 Ω		
Heater Strips 4/1 Resistance	9.20 to 9.60 Ω	9.290 Ω		

T. Price — Inspector

11-30-01 — Date

Perform a Hipot on the Collared Coil Assembly (**Maximum Leakage 2.5μA**)

5 KV	Measurement(s)
Heater #1/2 to Ground	1 μA
Heater #2/3 to Ground	1 μA
Heater #3/4 to Ground	1 μA
Heater #4/1 to Ground	1 μA
Heater #1/2 to All 4 Quadrants	1 μA
Heater #2/3 to All 4 Quadrants	1 μA
Heater #3/4 to All 4 Quadrants	1 μA
Heater #4/1 to All 4 Quadrants	1 μA
All 4 Quadrants to Ground	.5 μA

COIL TO COIL 3.0 KV	Measurement(s)
Quadrant 1 to Quadrant 2	.1 μA
Quadrant 2 to Quadrant 3	.1 μA
Quadrant 3 to Quadrant 4	.1 μA
Quadrant 4 to Quadrant 1	.2 μA

Inspector

11-30-01
Date

8.6 Verify that the results in Step 8.5 are acceptable.
Approved for next Assembly Procedure.

Responsible Authority/Physicist _____ Date _____

8.7 Thread the Coil Leads, Voltage Taps and Heater Strips through the openings of the End Can End Ring (MB-344533).

Technician(s) _____ Date _____

8.8 Place the End Can End Ring (MB-344533) onto the Tapered Ring (MC-344456).

Technician(s) _____ Date _____

8.9 Remove the old Strain Gage Wire RTV from the top and bottom instrumentation slots of the collared coil at both return and lead ends (only from areas where Strain Gage Wires had originally been "peeled back"). Re-apply Silicone Rubber Primer (Fermi stock 1940-1300) or equivalent onto the instrumentation slots and secure Strain Gage Wires into position with a mixture of RTV (Fermi stock 1940-0750) or equivalent.

Technician(s) _____ Date _____

TD / Engineering Fabrication

Specification No.: 5520-FM-318902
February 1, 2002
Rev. K

Traveler Title:	Specification No:	Revision:	DR No:
LHC End Can Installation Traveler	5520-TR-333496	A	HGQ-0292

Step No:	Drawing No:	Routing Form No:	Serial No:
11.0	ME-369580		MQXBC-002

Discrepancy Description:

Inner Q1 lead is protruding into the bore of the magnet.

Originator: Steve Gould

Date: 12/13/2001

Cause of Nonconformance:

Lead moved into the Bore while installing the Lead End Clamp. Radial Support of Lead was inadequate.

Responsible Authority: Rodger Bossert

Date: 12/13/2001

TD / Engineering Fabrication

Specification No.: 5520-FM-318902
February 1, 2002
Rev. K

Disposition:

Remove End Clamp. Re-install while manually supporting lead. (Re-issue 333496 Steps 7.1 to 8.9 (Green) & Step 10.2 (Pink) - John Szostak 12/17/01)

Responsible Authority: Rodger Bossert

Date: 12/13/2001

Corrective Action to Prevent Recurrence:

Need Tooling to hold leads in place while installing Lead End Clamps.

Responsible Authority: Rodger Bossert

Date: 2/8/2002

Corrective Action/Disposition Verified By: Rodger Bossert

Date: 12/13/2001

Will Configuration be affected?: ☐ YES ☑ NO

Identified problem area:

☐ Material ☐ Manpower ☑ Method ☐ Machine ☐ Measurement

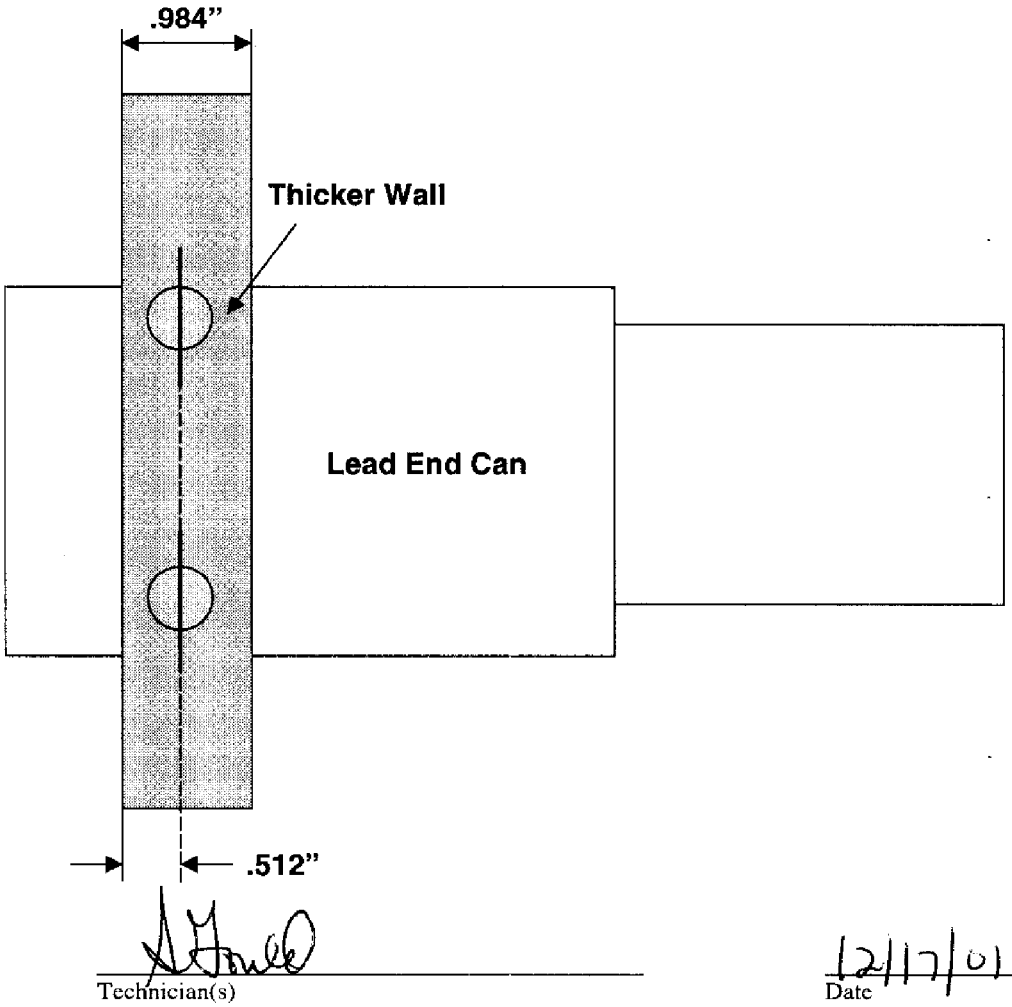
Reviewed By: Bob Jensen

Date: 2/8/2002

10.2 Obtain (1) Axial Preload Plate (MD-369094), and bolt it onto the outer surface of Lead End Tapered Ring as shown.

Note(s):

Make sure that the thicker wall of the Plate is on the inside.



Technician(s)

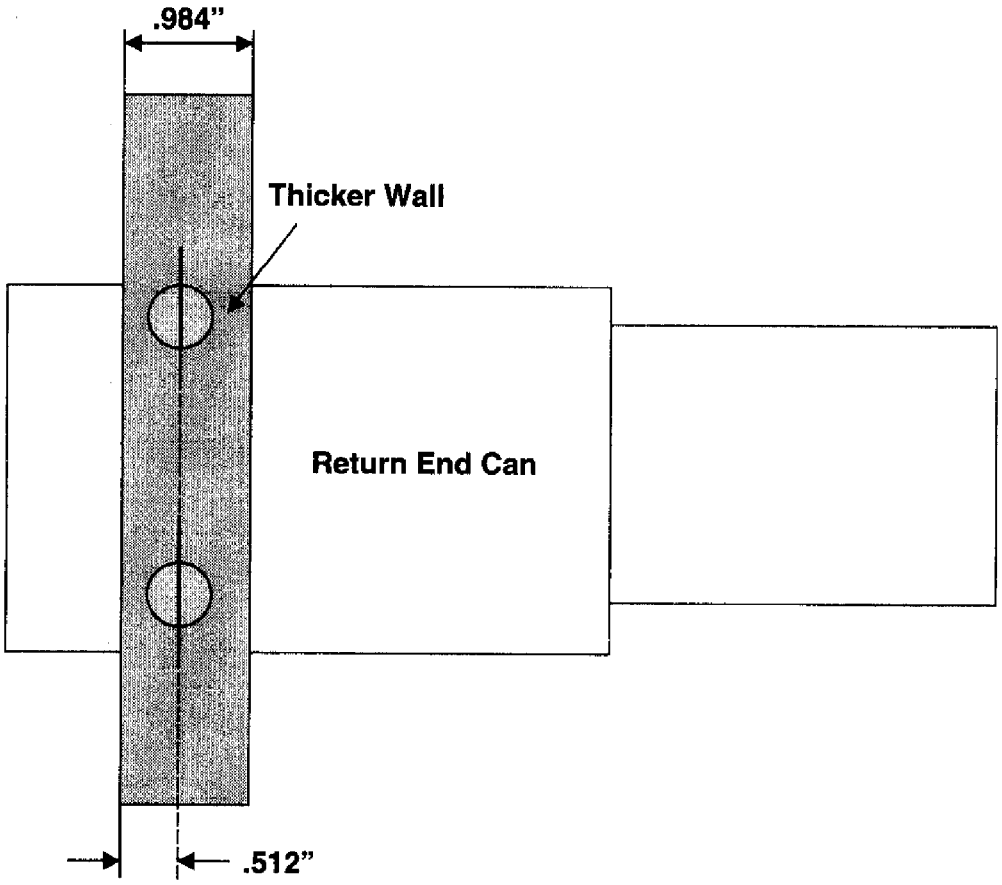
12/17/01
Date

10.0 Install End Axial Preload Plates

10.1 Obtain (1) Axial Preload Plate (MD-369094), and bolt it onto the outer surface of Return End Tapered Ring as shown.

Note(s):

Make sure that the thicker wall of the Plate is on the inside.



DR# HGQ-0292

N/A

Technician(s)

Date

7.0 Lead End Can Installation

7.1 Slide the Tapered Ring (MC-344456) using a Mylar sleeve, onto the Collared Coil.

D Mulcahy — 12-14-01
Technician(s) — Date

7.2 Bolt the (2) Pusher Plates (MC-369169) with .50 inch-13UNC x 13.0 inch Socket Head Cap Screws and 1/2" Flat Washers, onto the End Squeezer Assembly (ME-344350).

Note(s):

Pusher Plates must be installed with hydraulic cylinder sides facing towards center of the Coil as not to interfere with any wiring involved in the Lead End Assembly.

D Mulcahy — 12-14-01
Technician(s) — Date

7.3 Install the Kapton and the Filler Cone (MC-344457) atop the Saddles with Plastic Cable ties.

Caution:

Ensure dry lubricant coating remains intact and free of damage.

Record the amount of Kapton used:

N/A
Technician(s) — Date

TNRT 2.300 CAN BROKE FREE AT 2300 lbs

X 7.4 Slide the Tapered Ring Lead End (ME-344456) on to the Filler Cone Lead End (ME-344457) as per the Collared Coil with Ends (ME-369580).

Note(s):

Top of the Tapered Ring and the top of the Collared Coil match.
Strain Gage wires are on the outside of the Aluminum Tapered Ring.
Voltage Tap Wires are extended through the inside of the Aluminum Tapered Ring.

NA
Technician(s) Date

7.5 Position the Holder Plate with the installed Half Rings (MC-344359), until it contacts the back surface of the Filler Cone (ME-344457).

D Nuncyk 12-14-01
Technician(s) Date

7.6 Attach the Enerpac Hose to the Hydraulic Cylinders (Model RC 106) as per the Collared Coil End Squeezer Assembly (ME-344350).

Note(s):

Face shield must be worn during operation of hydraulic cylinders.

D Nuncyk 12-14-01
Technician(s) Date

7.7 Record Total Coil Starting Resistance 2298 Ω.

D Nuncyk 12-14-01
Technician Date

7.8 Gradually apply pressure to the End Squeezer Assembly until the Aluminum Tapered Ring covers the Filler Cone. Maximum Pump pressure is to be greater than 4000psi.

Maximum Pump Pressure 7300 PSI

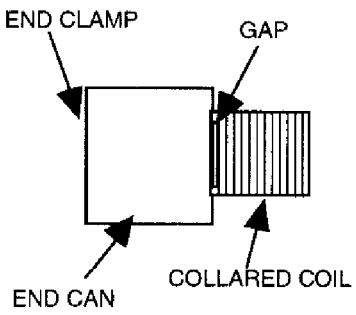
D Nuncyk 12-14-01
Technician(s) Date

7.9 Record Total Coil End Resistance 2299 Ω

D Nuncyk 12-14-01
Technician Date

7.10 Before removing the End Squeezer Assembly, measure the gap between the Filler Cone and the Coil Lamination, as shown below, using a Micrometer. The gap should be no more than 10 mils.

TRR# 1422



Gap Measurement Quad 1 .023

Gap Measurement Quad 2 .029

Gap Measurement Quad 3 .047

Gap Measurement Quad 4 .028

Technician(s) _____ Date 12-14-01

STOP

7.11 Verify that the results in Step 7.10 are acceptable.
Approved for next Assembly Procedure.

Responsible Authority/Physicist _____ Date 12-14-01

7.12 Remove the entire End Squeezer Assembly.

Technician(s) _____ Date 12-14-01

8.0 Lead End Can Inspection

8.1 Perform a Pi tape measurement on the Tapered Ring at the following locations.

TRR# 1295

NA

Distance from the Coil End of the Tapered Ring (A)	Pi Tape
0.0 inches	
1.0 inches	
2.0 inches	
3.0 inches	
4.0 inches	
5.0 inches	

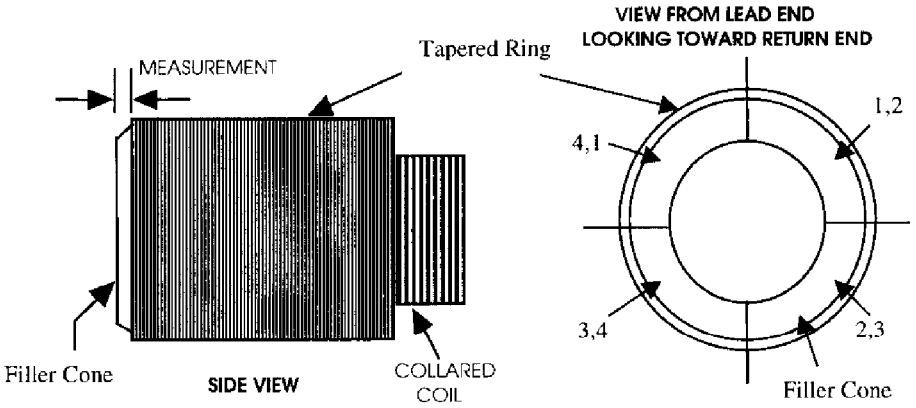
Technician(s) Date

8.2 Clean the Filler Cone using Isopropyl Alcohol (Fermi stock 1920-0300) and Kimwipes (Fermi stock 1660-2600) or equivalent.

NA

Technician(s) Date

8.3 Measure the distance between each Filler Cone and the Tapered Ring, using a Depth Gauge.

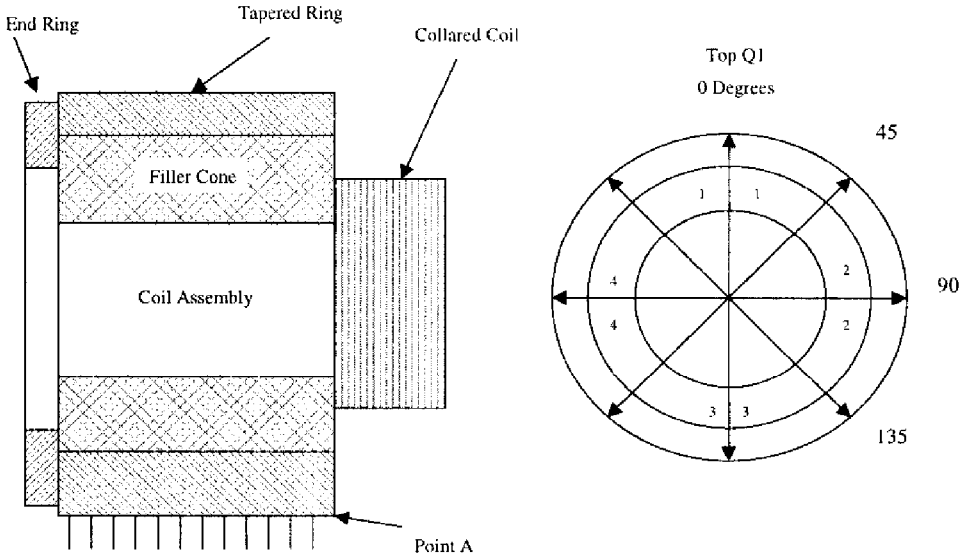


Filler Cone 1,2	.006
Filler Cone 2,3	.011
Filler Cone 3,4	.011
Filler Cone 1,4	.009
AVERAGE	.00925

Technician(s) 12-14-01 Date

8.4 Measure the diameter of the Tapered Ring (MC-344456) in the fully clamped state, at the 0, 45, 90 and 135 Degrees at 1" intervals using a 9"-10" Micrometer and PI Tape.

Looking from the Lead End to the Return End



Distance from the Coil End of the Tapered Ring (A)	0 Degrees	45 Degree	90 Degree	135 Degree	Pi Tape
0.00 inches	9.8475	9.850	9.850	9.8505	9.850
1.00 inches	9.849	9.850	9.851	9.8505	9.850
2.00 inches	9.8495	9.850	9.850	9.850	9.850
3.00 inches	9.850	9.851	9.850	9.8505	9.850
4.00 inches	9.850	9.851	9.851	9.8505	9.850
5.00 inches	9.850	9.851	9.851	9.8505	9.850
6.00 inches	9.850	9.851	9.850	9.850	9.850
7.00 inches	9.850	9.851	9.850	9.850	9.850
8.00 inches	9.850	9.851	9.849	9.850	9.850
9.00 inches	9.850	9.851	9.849	9.850	9.849
9.50 inches	9.850	9.852	9.849	9.850	9.850

Technician(s) _____ Date 12/14/01

8.5 Perform an electrical inspection on each of the individual Inner Coils, Outer Coils and Quadrants. Refer to the Valhalla and Leader Free Standing Coil Measurement Procedure (ES-292306), and the Procedure for Electrical Inspection of Voltage Taps (ES-301383).

Note(s):

Ensure that all measurements are recorded correctly, and have the proper value and symbol (i.e., mΩ, mH, etc.).

Valhalla 4300B settings:

Test current	Off (not testing)
Power	On
Full scale voltage	20mv
Amp selector knob	1A
Temperature compensator	On
Test current	On (testing)

Hp 4263 B:

Function	"Ls-Q" selected

Record the Serial Number of the test equipment used.

Valhalla 32-858

HP 4263b 2848500512

Resistance		Inner	Outer	Total	Pass	Fail
Nominal		345 mΩ to 390 mΩ	410 mΩ to 455 mΩ	560 to 585 mΩ		
Quadrant 1	Inner	.2562 mΩ				
	Outer		.3190 mΩ			
	Total			.5753 mΩ		
Quadrant 2	Inner	.2580 mΩ				
	Outer		.3192 mΩ			
	Total			.5747 mΩ		
Quadrant 3	Inner	.2571 mΩ				
	Outer		.3168 mΩ			
	Total			.5748 mΩ		
Quadrant 4	Inner	.2578 mΩ				
	Outer		.3192 mΩ			
	Total			.5755 mΩ		
Total Magnet		Nominal	2.3 Ω	Ω		

Inductance		Inner	Outer	Total	Pass	Fail
Nominal		620-650 µH	1.120 to 1.17 mH	2.880 to 2.935 mH		
Quadrant 1	Inner	886.46 µH				
	Outer		1.22087 mH			
	Total			2.3048 mH		
Quadrant 2	Inner	857.516 µH				
	Outer		1.19318 mH			
	Total	S.N6		2.3064 mH		
Quadrant 3	Inner	850.520 µH				
	Outer		1.15985 mH			
	Total			2.31276 mH		
Quadrant 4	Inner	760.189 µH				
	Outer		1.09846 mH			
	Total			2.3132 mH		
Total Magnet		Nominal	17 mH	mH		

Q-Factor		Inner	Outer	Total	Pass	Fail
Nominal		3.0 to 3.5	4.3 to 5.0	4.5 to 5.2		
Quadrant 1	Inner	2.05				
	Outer		2.24			
	Total			5.26		
Quadrant 2	Inner	2.02				
	Outer		2.22			
	Total			5.27		
Quadrant 3	Inner	1.89				
	Outer		2.18			
	Total			5.29		
Quadrant 4	Inner	1.77				
	Outer		2.04			
	Total			5.29		
Total Magnet		Nominal	4.3			

Inspector

12/14/01
Date

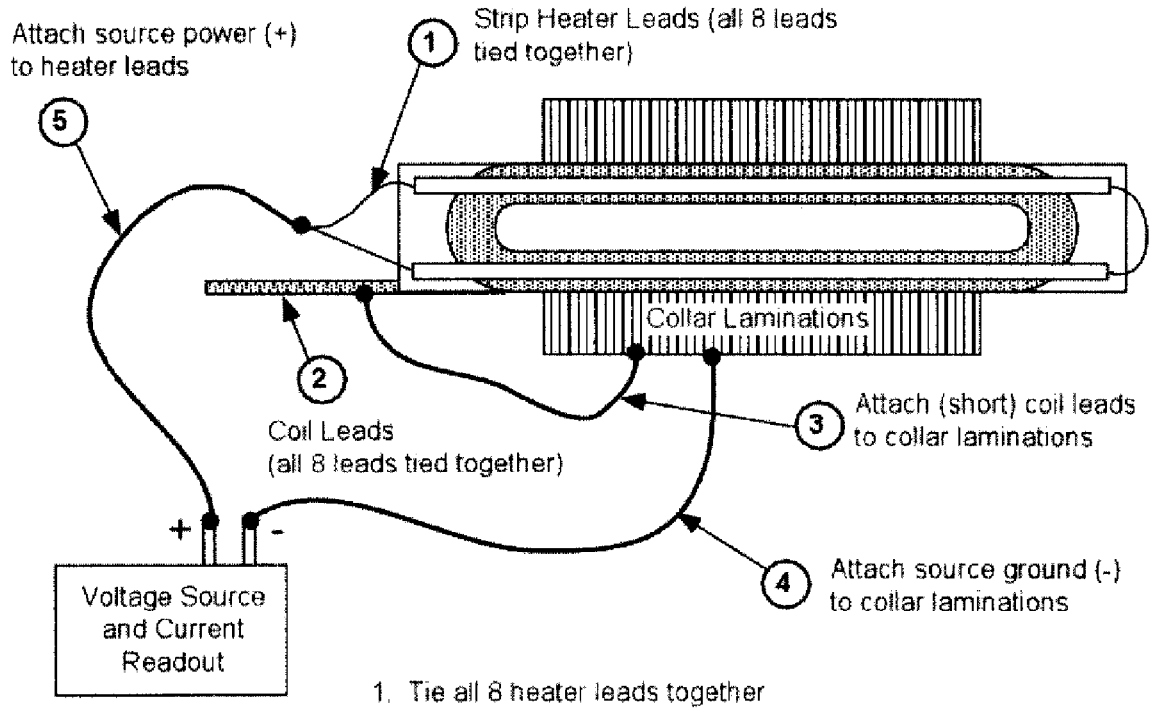
Electrical Test	Limit	Actual Measurement	Pass	Fail
Heater Strips 1/2 Resistance	9.20 to 9.60 Ω	9.225 Ω		
Heater Strips 2/3 Resistance	9.20 to 9.60 Ω	9.225 Ω		
Heater Strips 3/4 Resistance	9.20 to 9.60 Ω	9.274 Ω		
Heater Strips 4/1 Resistance	9.20 to 9.60 Ω	9.487 Ω		

Inspector

12/14/01
Date

Perform a Hipot on the Collared Coil Assembly **(Maximum Leakage 3 μA).**

1st Hipot - Heaters to both Coil and Ground



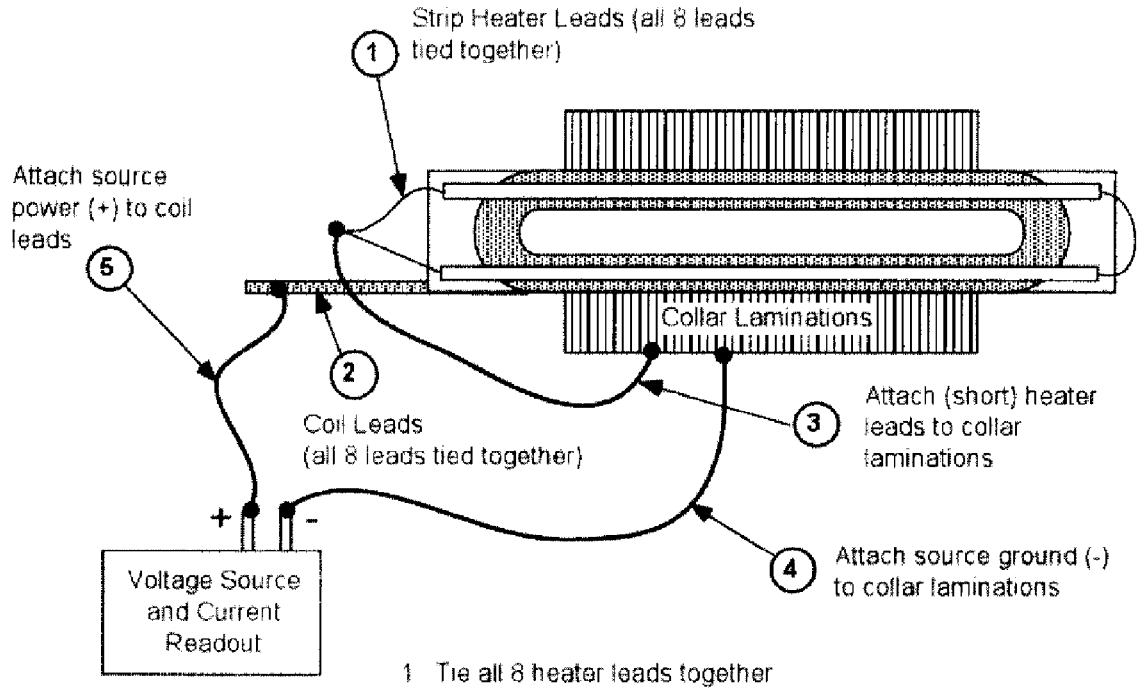
1. Tie all 8 heater leads together
2. Tie all 8 coil leads together
3. Attach (short) coil leads to collar laminations
4. Attach source ground (-) to collar laminations
5. Attach source power (+) to heater leads
6. Increase voltage to 5kv or until leakage exceeds 3uA

5 KV	Measurement(s)
Heaters to Ground (Coils Grounded)	DN .03 .3 uA

Don Murphy
Inspector

12-17-01
Date

2nd Hipot - Coil to Ground Hipot



1. Tie all 8 heater leads together
2. Tie all 8 coil leads together
3. Attach (short) heater leads to collar laminations
4. Attach source ground (-) to collar laminations
5. Attach source power (+) to coil leads
6. Increase voltage to 5kv or until leakage exceeds 3uA

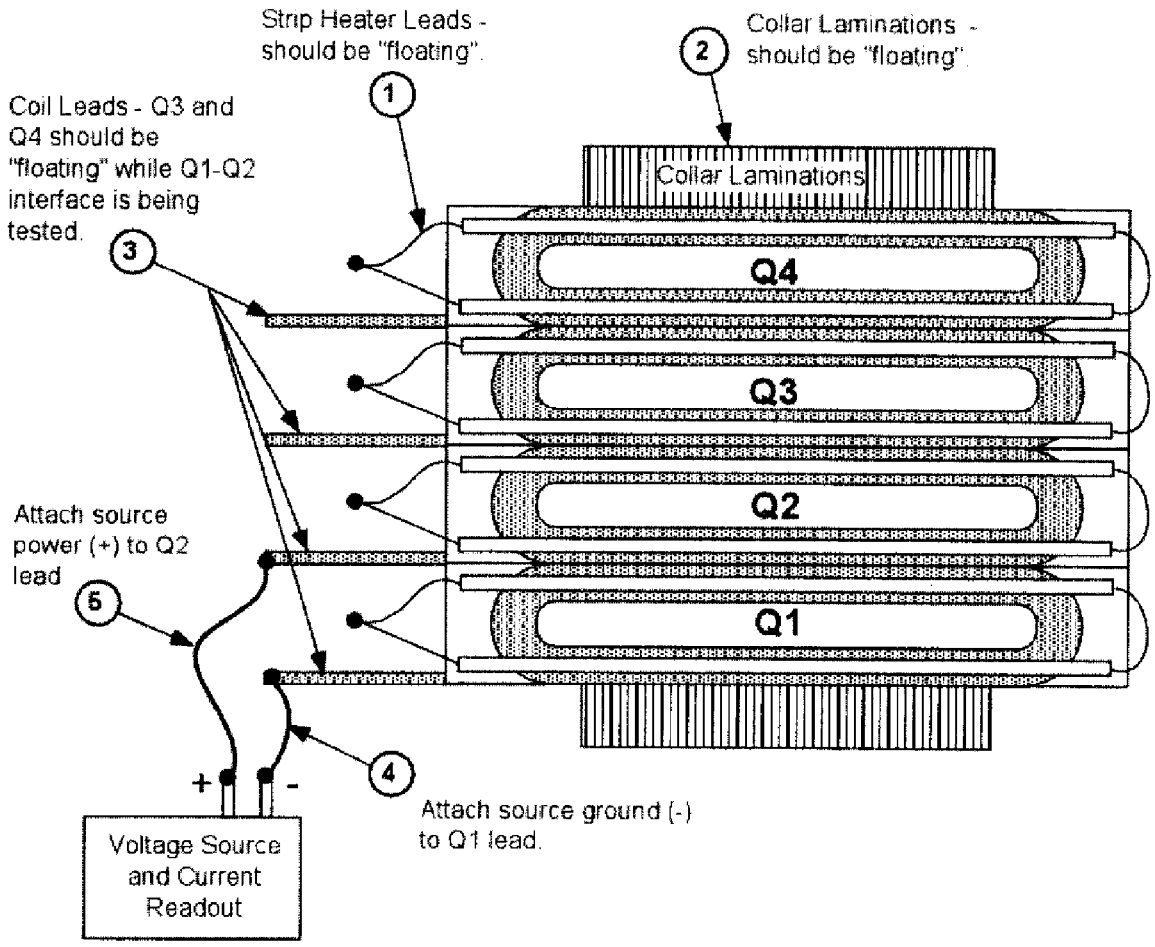
5 KV	Measurement(s)
Coils to Ground (Heaters Grounded)	.2 uA

D Mucyk
Inspector

12-17-01
Date

3rd Hipot - Quadrant-to-Quadrant Hipot

(4 quadrants shown "developed")



1. Make sure all heaters are "floating" (electrically isolated)
2. Make sure all collar laminations are "floating" (electrically isolated)
3. Make sure all leads from Q3 and Q4 coils are "floating" (electrically isolated)
4. Attach source ground (-) to Q1 lead (either inner or outer coil)
   Other end (either inner or outer coil) must be electrically isolated
5. Attach source power (+) to Q2 lead (either inner or outer coil)
   Other end (either inner or outer coil) must be electrically isolated
6. Increase voltage to 3kv or until leakage exceeds 3uA
7. Repeat steps 3-6 for Q2-Q3 leads
8. Repeat steps 3-6 for Q3-Q4 leads
9. Repeat steps 3-6 for Q4-Q1 leads

Coil to Coil @ 3.0 KV	Measurement(s)
Quadrant 1 to Quadrant 2	.1 uA
Quadrant 2 to Quadrant 3	.1 uA
Quadrant 3 to Quadrant 4	.1 uA
Quadrant 4 to Quadrant 1	.1 uA

Inspector — Date: 12-17-01

STOP

8.6 Verify that the results in Step 8.6 are acceptable.
Approved for next Assembly Procedure.

Responsible Authority/Physicist — Date: 12-17-01

8.7 Thread the Coil Leads, Voltage Taps and Heater Strips through the openings of the End Can End Ring (MB-344533).

Technician(s) — Date: 12/18/01

8.8 Place the End Can End Ring (MB-344533) onto the Tapered Ring (MC-344456).

Technician(s) — Date: 12/18/01

TRR# 1422

8.9 Remove the old Strain Gage Wire RTV from the top and bottom instrumentation slots of the collared coil at both return and lead ends (only from areas where Strain Gage Wires had originally been "peeled back"). Re-apply Silicone Rubber Primer (Fermi stock 1940-1300) or equivalent onto the instrumentation slots and secure Strain Gage Wires into position with a mixture of RTV (Fermi stock 1940-0750) or equivalent.

Technician(s): N/A — Date:

Revision Request Control Number: 1288

Specification Number: 5520 - TR - 333496 Current Revision: A

Traveler or Document Title: LHC End Can Installation Traveler

Step #/Description of Revision:

3.6 Deleted Step. Etching the Magnet Serial Number is completed in Step 6.6.

Damon Bice	Jim Rife	11/21/2001
Originator	Responsible Authority	Date

Revision Incorporated into the Traveler:	John Szostak	11/21/2001
	Revision Incorporated By	Date

Process Engineering Final Review:	Bob Jensen	11/21/2001
	Process Engineering/Designee	Date

Instructions for the completion of the Revision Request Form

Note(s):

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Originator Instructions:

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2) Current Revision: - Enter the Revision of the Traveler or Document to be revised.

3) Step# / Description of the Revision: - Enter a description of the revision to be made and the step# it applies to, if applicable. If needed to describe the revision attach a copy of the page(s). If the revision is coming from a related document such as a Discrepancy Report or an Engineering Order attach a copy of that document to the Revision Request Form.

4) Originator: - Originator is the person generating the form. (Select Name from List)

5) Responsible Authority: - Responsible Authority is person responsible for the process in question. (Select Name from List)

Process Engineering Office Instructions:

1) Revision Incorporated into the Traveler: - Signature of the individual who incorporated the revision.

2) Process Engineering Final Review: - Review the Traveler or Document revised, sign and date the form. The original completed Revision Request Form will be retained by the Process Engineering Office in the Revision Request Binder.

Revision Request Control Number: 1289

Specification Number: 5520 - TR - 333496 Current Revision: A

Traveler or Document Title: LHC End Can Installation Traveler

Step #/Description of Revision:

5.5 Modified Step. Delete Hipot.

Damon Bice	Jim Rife	11/21/2001
Originator	Responsible Authority	Date
Revision Incorporated into the Traveler:	John Szostak	11/21/2001
	Revision Incorporated By	Date
Process Engineering Final Review:	Bob Jensen	11/21/2001
	Process Engineering/Designee	Date

Instructions for the completion of the Revision Request Form

Note(s):

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2) Current Revision: - Enter the Revision of the Traveler or Document to be revised.

3) Step# / Description of the Revision: - Enter a description of the revision to be made and the step# it applies to, if applicable. If needed to describe the revision attach a copy of the page(s). If the revision is coming from a related document such as a Discrepancy Report or an Engineering Order attach a copy of that document to the Revision Request Form.

4) Originator: - Originator is the person generating the form. (Select Name from List)

5) Responsible Authority: - Responsible Authority is person responsible for the process in question. (Select Name from List)

Process Engineering Office Instructions:

1) Revision Incorporated into the Traveler: - Signature of the individual who incorporated the revision.

2) Process Engineering Final Review: - Review the Traveler or Document revised, sign and date the form. The original completed Revision Request Form will be retained by the Process Engineering Office in the Revision Request Binder.

Revision Request Control Number: 1290

Specification Number: 5520 - TR - 333496 Current Revision: A

Traveler or Document Title: LHC End Can Installation Traveler

Step #/Description of Revision:

5.5 Delete 1/8 Coil Tap wires Table.

Damon Bice	Jim Rife	11/21/2001
Originator	Responsible Authority	Date

Revision Incorporated into the Traveler:	John Szostak	11/21/2001
	Revision Incorporated By	Date

Process Engineering Final Review:	Bob Jensen	11/21/2001
	Process Engineering/Designee	Date

Instructions for the completion of the Revision Request Form

Note(s):

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Originator Instructions:

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2) Current Revision: - Enter the Revision of the Traveler or Document to be revised.

3) Step# / Description of the Revision: - Enter a description of the revision to be made and the step# it applies to, if applicable. If needed to describe the revision attach a copy of the page(s). If the revision is coming from a related document such as a Discrepancy Report or an Engineering Order attach a copy of that document to the Revision Request Form.

4) Originator: - Originator is the person generating the form. (Select Name from List)

5) Responsible Authority: - Responsible Authority is person responsible for the process in question. (Select Name from List)

Process Engineering Office Instructions:

1) Revision Incorporated into the Traveler: - Signature of the individual who incorporated the revision.

2) Process Engineering Final Review: - Review the Traveler or Document revised, sign and date the form. The original completed Revision Request Form will be retained by the Process Engineering Office in the Revision Request Binder.

Revision Request Control Number: 1291

Specification Number: 5520 - TR - 333496 Current Revision: A

Traveler or Document Title: LHC End Can Installation Traveler

Step #/Description of Revision:

5.7 Delete Step. No Voltage Taps to thread through End Can End Ring.
Added Note to New Step 5.7 (Old Step 5.8) "Note(s): Ensure Heater Strips Pass through the openings of the End Can End Ring (MB-344533)."

Damon Bice	Jim Rife	11/21/2001
Originator	Responsible Authority	Date
Revision Incorporated into the Traveler:	John Szostak	11/21/2001
	Revision Incorporated By	Date
Process Engineering Final Review:	Bob Jensen	11/21/2001
	Process Engineering/Designee	Date

Instructions for the completion of the Revision Request Form

Note(s):

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Originator Instructions:

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2) Current Revision: - Enter the Revision of the Traveler or Document to be revised.

3) Step# / Description of the Revision: - Enter a description of the revision to be made and the step# it applies to, if applicable. If needed to describe the revision attach a copy of the page(s). If the revision is coming from a related document such as a Discrepancy Report or an Engineering Order attach a copy of that document to the Revision Request Form.

4) Originator: - Originator is the person generating the form. (Select Name from List)

5) Responsible Authority: - Responsible Authority is person responsible for the process in question. (Select Name from List)

Process Engineering Office Instructions:

1) Revision Incorporated into the Traveler: - Signature of the individual who incorporated the revision.

2) Process Engineering Final Review: - Review the Traveler or Document revised, sign and date the form. The original completed Revision Request Form will be retained by the Process Engineering Office in the Revision Request Binder.

Revision Request Control Number: 1292

Specification Number: 5520 - TR - 333496 Current Revision: A

Traveler or Document Title: LHC End Can Installation Traveler

Step #/Description of Revision:

5.9 Delete Step. No Strain Gauge Wires.

Damon Bice	Jim Rife	11/21/2001
Originator	Responsible Authority	Date
Revision Incorporated into the Traveler:	John Szostak	11/21/2001
	Revision Incorporated By	Date
Process Engineering Final Review:	Bob Jensen	11/21/2001
	Process Engineering/Designee	Date

Instructions for the completion of the Revision Request Form

Note(s):

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Originator Instructions:

1) Specification Number: - Enter the Specification Number of the Traveler or Document to be revised. (Document title is inserted automatically from the spec. #)

2) Current Revision: - Enter the Revision of the Traveler or Document to be revised.

3) Step# / Description of the Revision: - Enter a description of the revision to be made and the step# it applies to, if applicable. If needed to describe the revision attach a copy of the page(s). If the revision is coming from a related document such as a Discrepancy Report or an Engineering Order attach a copy of that document to the Revision Request Form.

4) Originator: - Originator is the person generating the form. (Select Name from List)

5) Responsible Authority: - Responsible Authority is person responsible for the process in question. (Select Name from List)

Process Engineering Office Instructions:

1) Revision Incorporated into the Traveler: - Signature of the individual who incorporated the revision.

2) Process Engineering Final Review: - Review the Traveler or Document revised, sign and date the form. The original completed Revision Request Form will be retained by the Process Engineering Office in the Revision Request Binder.

Revision Request Control Number: 1294

Specification Number: 5520 - TR - 333496 Current Revision: A

Traveler or Document Title: LHC End Can Installation Traveler

Step #/Description of Revision:

6.6 Modified Step. Do not etch the Return End Can.

Damon Bice	Jim Rife	11/21/2001
Originator	Responsible Authority	Date

Revision Incorporated into the Traveler:	John Szostak	11/21/2001
	Revision Incorporated By	Date

Process Engineering Final Review:	Bob Jensen	11/21/2001
	Process Engineering/Designee	Date

Instructions for the completion of the Revision Request Form

Note(s):

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2) Current Revision: - Enter the Revision of the Traveler or Document to be revised.

3) Step# / Description of the Revision: - Enter a description of the revision to be made and the step# it applies to, if applicable. If needed to describe the revision attach a copy of the page(s). If the revision is coming from a related document such as a Discrepancy Report or an Engineering Order attach a copy of that document to the Revision Request Form.

4) Originator: - Originator is the person generating the form. (Select Name from List)

5) Responsible Authority: - Responsible Authority is person responsible for the process in question. (Select Name from List)

Process Engineering Office Instructions:

1) Revision Incorporated into the Traveler: - Signature of the individual who incorporated the revision.

2) Process Engineering Final Review: - Review the Traveler or Document revised, sign and date the form. The original completed Revision Request Form will be retained by the Process Engineering Office in the Revision Request Binder.

Revision Request Control Number: 1295

Specification Number: 5520 - TR - 333496 Current Revision: A

Traveler or Document Title: LHC End Can Installation Traveler

Step #/Description of Revision:

6.10 Delete Step.

Damon Bice	Jim Rife	11/21/2001
Originator	Responsible Authority	Date
Revision Incorporated into the Traveler:	John Szostak	11/21/2001
	Revision Incorporated By	Date
Process Engineering Final Review:	Bob Jensen	11/21/2001
	Process Engineering/Designee	Date

Instructions for the completion of the Revision Request Form

Note(s):

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Originator Instructions:

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2) Current Revision: - Enter the Revision of the Traveler or Document to be revised.

3) Step# / Description of the Revision: - Enter a description of the revision to be made and the step# it applies to, if applicable. If needed to describe the revision attach a copy of the page(s). If the revision is coming from a related document such as a Discrepancy Report or an Engineering Order attach a copy of that document to the Revision Request Form.

4) Originator: - Originator is the person generating the form. (Select Name from List)

5) Responsible Authority: - Responsible Authority is person responsible for the process in question. (Select Name from List)

Process Engineering Office Instructions:

1) Revision Incorporated into the Traveler: - Signature of the individual who incorporated the revision.

2) Process Engineering Final Review: - Review the Traveler or Document revised, sign and date the form. The original completed Revision Request Form will be retained by the Process Engineering Office in the Revision Request Binder.

Revision Request Control Number: 1298

Specification Number: 5520 - TR - 333496 Current Revision: A

Traveler or Document Title: LHC End Can Installation Traveler

Step #/Description of Revision:

5.1 Delete Step. Measurements taken in Step 5.4.
8.1 Delete Step. Measurements taken in Step 8.4.

Damon Bice	Jim Rife	11/21/2001
Originator	Responsible Authority	Date
Revision Incorporated into the Traveler:	John Szostak	11/21/2001
	Revision Incorporated By	Date
Process Engineering Final Review:	Bob Jensen	11/21/2001
	Process Engineering/Designee	Date

Instructions for the completion of the Revision Request Form

Note(s):

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Originator Instructions:

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2) Current Revision: - Enter the Revision of the Traveler or Document to be revised.

3) Step# / Description of the Revision: - Enter a description of the revision to be made and the step# it applies to, if applicable. If needed to describe the revision attach a copy of the page(s). If the revision is coming from a related document such as a Discrepancy Report or an Engineering Order attach a copy of that document to the Revision Request Form.

4) Originator: - Originator is the person generating the form. (Select Name from List)

5) Responsible Authority: - Responsible Authority is person responsible for the process in question. (Select Name from List)

Process Engineering Office Instructions:

1) Revision Incorporated into the Traveler: - Signature of the individual who incorporated the revision.

2) Process Engineering Final Review: - Review the Traveler or Document revised, sign and date the form. The original completed Revision Request Form will be retained by the Process Engineering Office in the Revision Request Binder.

Revision Request Control Number: 1299

Specification Number: 5520 - TR - 333496 Current Revision: A

Traveler or Document Title: LHC End Can Installation Traveler

Step #/Description of Revision:

8.5 Delete 1/8 Coil Tap wires Table.

Damon Bice	Jim Rife	11/21/2001
Originator	Responsible Authority	Date
Revision Incorporated into the Traveler:	John Szostak	11/21/2001
	Revision Incorporated By	Date
Process Engineering Final Review:	Bob Jensen	11/21/2001
	Process Engineering/Designee	Date

Instructions for the completion of the Revision Request Form

Note(s):

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Originator Instructions:

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2) Current Revision: - Enter the Revision of the Traveler or Document to be revised.

3) Step# / Description of the Revision: - Enter a description of the revision to be made and the step# it applies to, if applicable. If needed to describe the revision attach a copy of the page(s). If the revision is coming from a related document such as a Discrepancy Report or an Engineering Order attach a copy of that document to the Revision Request Form.

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5) Responsible Authority: - Responsible Authority is person responsible for the process in question. (Select Name from List)

Process Engineering Office Instructions:

1) Revision Incorporated into the Traveler: - Signature of the individual who incorporated the revision.

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Revision Request Control Number: 1422

Specification Number: 5520 - TR - 333496 Current Revision: D

Traveler or Document Title: LHC End Can Installation Traveler

Step #/Description of Revision:

3.3 Modified Step. Changed First Column Header of Table to "Distance from the Collar Side of the Tapered Ring (A)".
3.5 Modified Step. Changed First Column Header of Table to "Distance from the Collar Side of the Tapered Ring (A)".
3.8 Modified Step. Changed "Dry Lubricant" to "DRYFILM DF250/IPA or equivalent" in Step and in Note(s) section.
3.9 Modified Step. Removed Strain Gauge comments from Note(s) section.
Added: "(using the LHC Lifting Fixture 318718)"
4.2 Modified Step. Removed Note: "Note(s): Pusher Plates must be installed with hydraulic cylinder sides facing towards center of Coil as not to interfere with any wiring involved in Lead End Assembly." Note is Obsolete.
4.4 Modified Step. Removed Note "Voltage Tap Wires are extended through the inside of the Aluminum Tapered Ring." No Voltage Taps as of MQXB03.
5.3 Modified Step. Changed "Depth Gauge" to "Gauge Block and Feeler Gauges".
5.4 Modified Step. Removed "and the Procedure for Electrical Inspection of Voltage Taps (ES-301383)."
No Voltage Taps as of MQXB03.Changed First Column Header of Table to "Distance from the Collar Side of the Tapered Ring (A)". Changed Resistance, Inductance and Q factor Tables to record Total values only.
Changed Full scale voltage to 2V.
6.3 Modified Step. Changed First Column Header of Table to "Distance from the Collar Side of the Tapered Ring (A)".
6.5 Modified Step. Changed First Column Header of Table to "Distance from the Collar Side of the Tapered Ring (A)".
6.6 Modified Step. Deleted "Grind slots into the End Can End Ring (MB-344533) on the Lead End to allow for the IORS Volt Tap Wires to pass." No Volt Tap wires as of MQXB03.
5.9 Modified Step. Changed "Dry Lubricant" to "DRYFILM DF250/IPA or equivalent" in Step and in Note(s) section.
7.3 Added Step. "Slide the Tapered Ring (MC-344456) using a Mylar sleeve, onto the Collared Coil."
7.6 Modified Step. Removed Note "Voltage Tap Wires are extended through the inside of the Aluminum Tapered Ring." No Voltage Taps as of MQXB03.
7.12 Modified Step. Deleted last sentence "The gap should be no more than 10 mils."
8.1 Removed Step. "Perform a Pi tape measurement on the Tapered Ring at the following locations."
Performed in Step 8.4
8.3 Modified Step. Changed "Depth Gauge" to "Gauge Block and Feeler Gauges".
8.5 Modified Step. Changed Resistance, Inductance and Q factor Tables to record Total values only.

Damon Bice	Jim Rife	2/26/2002
Originator	Responsible Authority	Date

Revision Incorporated into the Traveler:

John Szostak	2/27/2002
Revision Incorporated By	Date

Process Engineering Final Review:

Bob Jensen	2/27/2002
Process Engineering/Designee	Date

Instructions for the completion of the Revision Request Form

Note(s):

Multiple steps may be effected by one Revision Request Form but only one specific Traveler or Document may be effected by each Revision Request Form.

If completing this form by hand, a Revision Request Control Number must be obtained before processing.

If completing this form entirely by electronic means, the printed copy to be filed in the Process Engineering Office is to be initialed by the individual incorporating the Revision Request and the individual who reviewed the Traveler or Document.

Originator Instructions:

1) Specification Number: - Enter the Specification Number of the Traveler or Document to be revised. (Document title is inserted automatically from the spec. #)

2) Current Revision: - Enter the Revision of the Traveler or Document to be revised.

3) Step# / Description of the Revision: - Enter a description of the revision to be made and the step# it applies to, if applicable. If needed to describe the revision attach a copy of the page(s). If the revision is coming from a related document such as a Discrepancy Report or an Engineering Order attach a copy of that document to the Revision Request Form.

4) Originator: - Originator is the person generating the form. (Select Name from List)

5) Responsible Authority: - Responsible Authority is person responsible for the process in question. (Select Name from List)

Process Engineering Office Instructions:

1) Revision Incorporated into the Traveler: - Signature of the individual who incorporated the revision.

2) Process Engineering Final Review: - Review the Traveler or Document revised, sign and date the form. The original completed Revision Request Form will be retained by the Process Engineering Office in the Revision Request Binder.

lamination rounding and the mandrel hole problem had been corrected by MQXB02, and we still saw this happen. To some degree, we can blame the MQXB02 failure on the fact that the lead end lams were pressed into the coil three separate times, and the end can was removed twice, before the short appeared. This kind of stuff frequently happens with repeated rebuilds. Nevertheless, we have a weakness here that should be addressed.

Now, you might ask, "Why didn't this happen in the short magnet program? Didn't we build five (HGQ05-HGQ09) short models with the same lamination design, without incident?" Yes we did, but, looking back at the details, there are reasons why it didn't happen there:

1. HGQ05-HGQ07 had bearing strips, which just happened to cover that gap radially, protecting the ground wrap from that spot. We proved long ago that we don't need bearing strips (or collaring shoes) to protect the insulation from the full laminations, but the pinching problem in the corner was one I did not foresee. Also, HGQ05-07 were built before we started splitting the ground wrap at the corner. So we had four pieces of ground wrap, rather than 2, at that corner. Therefore, it was only HGQ08 and HGQ09 that actually were subjected to the same situation that the long magnets were, a much smaller "statistical base". But still, they were fine.

2. HGQ08 and HGQ09 did not have any bunching problems with ground wrap at the ends, as did P1 and MQXB01. Maybe that is why we did not have shorts of this nature. Also, HGQ09 was keyed only once, and HGQ08 was keyed twice. Both had only one end clamp installation. The only long magnet we made since we solved the bunching problem, MQXB02, only failed after being keyed 3 times and having the lead end clamp installed twice.

We have not taken apart HGQ08 or HGQ09 to see if pinching exists, or if the ground wrap is weak in those areas. We do have a mechanical model that was built just like the long magnets, and I see no sign of pinching. So I am a little puzzled as to why the problem seems to be worse on the long magnets.

Anyway, if this were two years ago, and we still had not finalized the design of the collar lamination , the solution would be simple. We could make the "small" collar lamination a little wider, and the "large" lamination a little smaller, causing the intermittent unsupported gap to be completely on the radial surface. But since we can't, we need a different solution. There are, I think, several solutions, some of which are not too painful. I will talk to the techs, look at the ground wrap in the area where we remove the collar packs, and try and write up some possibilities to discuss when you return.