Fermi National Accelerator Laboratory
Batavia, IL 60510

LARGE HADRON COLLIDER
MAGNET ASSEMBLY TRAVELER

Reference Drawing(s)
Cold Mass Coil Insulation Assembly
MC-369582

Scannable Pages 39

Budget Code: LOT	**Project Code:** LHC
Released by:	**Date:** 10/1/01
Prepared by: M. Cullen	

Title	Signature	Date
TD/E&F Process Engineering	Bob Jensen / Designee	05SEP01
TD/LHC Production Supervisor	Jim Kerby / Designee	9-5-01
TD/LHC Production Engineer	Rodger Bossert / Designee	9-5-01
TD/LHC Tooling Engineer	John Carson / Designee	9/5/01
TD / LHC Program Manager	Jim Kerby / Designee	9/5/01

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	9/29/00
A	4.0	Changed assembly order to Q1 I, O then Q2 I, O then Q3 I, O then Q4 I, O.	1179	5/25/01
	5.0	Added Limits		
	6.0	Added Space for Volt Tap Drawing, and Spot heater Number, Resistance.		
	9.4	Added Limits.		
B	6.0	Modify Preform Length as needed to fit inside of the Lead End outer Keys	1199	9/5/01
	6.0	Removed Spot Heaters and Volt Taps		
	4.0	Changed assembly order to all Inners, then all outers.		
	5.1 / 9.4	Removed electrical limits, and added Engineer signoff.		
	4.10	Added engineer sign off for the Coil length.		
	8.0	Changed the assembly process to by Quadrant instead of by product		

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) shall be worn 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 with Green Herculite (Fermi stock 1740-0100) when not being serviced or assembled.

2.0 Parts Kit List

2.1 Attach the completed Parts Kit for this production operation to this traveler. Ensure that the serial number on the Parts Kit matches the serial number of this traveler. Verify that the Parts Kit received is complete.

In Original Traveler — 10/4/01

Process Engineering/Designee — Date

STOP

2.2 Attach figure with Coil Serial Numbers, Locations and Shimming Dimensions.

10-1-01

Responsible Authority/Physicist — Date

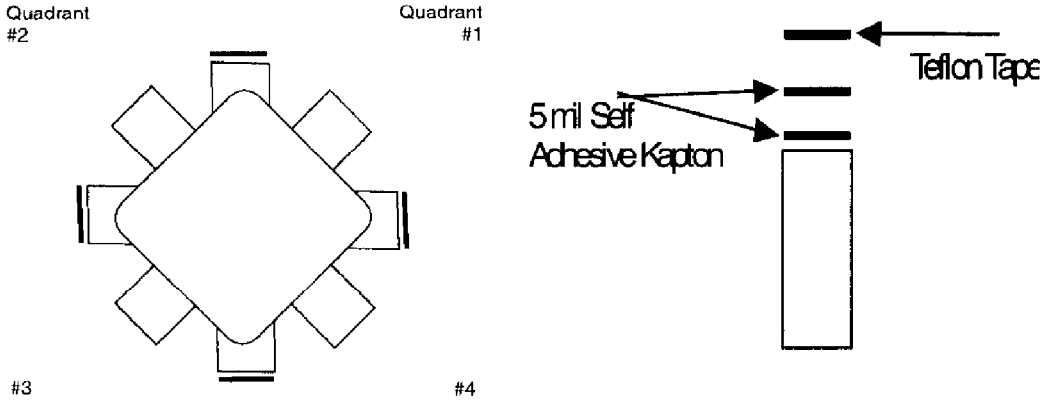
3.0 Mandrel Preparation

3.1 Clean the Coil Assembly/Collaring Mandrel (ME-369016) using lint free Heavy Duty Wipers (Fermi stock 1660-0150) and Isopropyl Alcohol (Fermi stock 1920-0300) or equivalent, and install in the Coil Assembly and Rollover Fixture.

N/A

Technician(s) Date

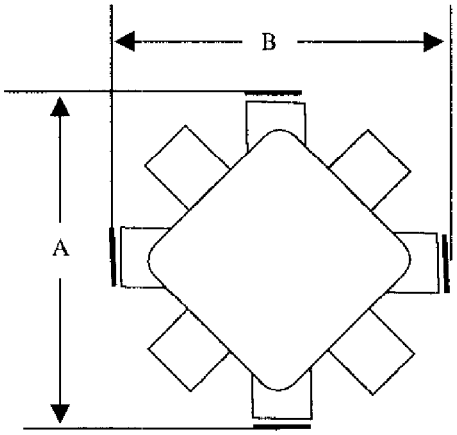
3.2 Shim the length of the Mandrel with 2 layers of 5 mil self adhesive Kapton, and 1 layer of 2", 3mil Teflon tape (MA-116533) or equivalent on the Parting Plane of the Mandrel.



N/A

Technician(s) Date

X 3.3 Measure the Mandrel Shimming.



	Limits	Lead End	Middle	Return End
A	**< 2.740"**			
B	**< 2.740"**			

N/A

Inspector Date

3.4 Mark the Mandrel at 25.5" from the Return End of the Mandrel for all four quadrants.

N/A

Technician(s) Date

4.0 Assemble the Coils

Note(s):

Ensure the Outer Coils are installed with the Inner Coil Preform in contact with the Outer Lead End Key.
Ensure all Inner Lead End Keys are Coplanar

4.1 Install the Coil per Figure in Step 2.2 in to Quadrant #1 Inner Coil as per the Rollover and Assembly Station Operating Procedure (OP-333505), using the Insertion/Extraction Fixture (MC-344719) as per the Insertion/Extraction Fixture Operating Procedure (OP-333504).

N/A _____
Technician(s) Date

4.2 Install the Coil per Figure in Step 2.2 in to Quadrant #2 Inner Coil as per the Rollover and Assembly Station Operating Procedure (OP-333505), using the Insertion/Extraction Fixture (MC-344719) as per the Insertion/Extraction Fixture Operating Procedure (OP-333504).

N/A _____
Technician(s) Date

4.3 Install the Coil per Figure in Step 2.2 in to Quadrant #3 Inner Coil as per the Rollover and Assembly Station Operating Procedure (OP-333505), using the Insertion/Extraction Fixture (MC-344719) as per the Insertion/Extraction Fixture Operating Procedure (OP-333504).

N/A _____
Technician(s) Date

4.4 Install the Coil per Figure in Step 2.2 in to Quadrant #4 Inner Coil as per the Rollover and Assembly Station Operating Procedure (OP-333505), using the Insertion/Extraction Fixture (MC-344719) as per the Insertion/Extraction Fixture Operating Procedure (OP-333504).

N/A _____
Technician(s) Date

4.5 Install the Coil per Figure in Step 2.2 in to Quadrant #4 Outer Coil as per the Rollover and Assembly Station Operating Procedure (OP-333505), using the Insertion/Extraction Fixture (MC-344719) as per the Insertion/Extraction Fixture Operating Procedure (OP-333504).

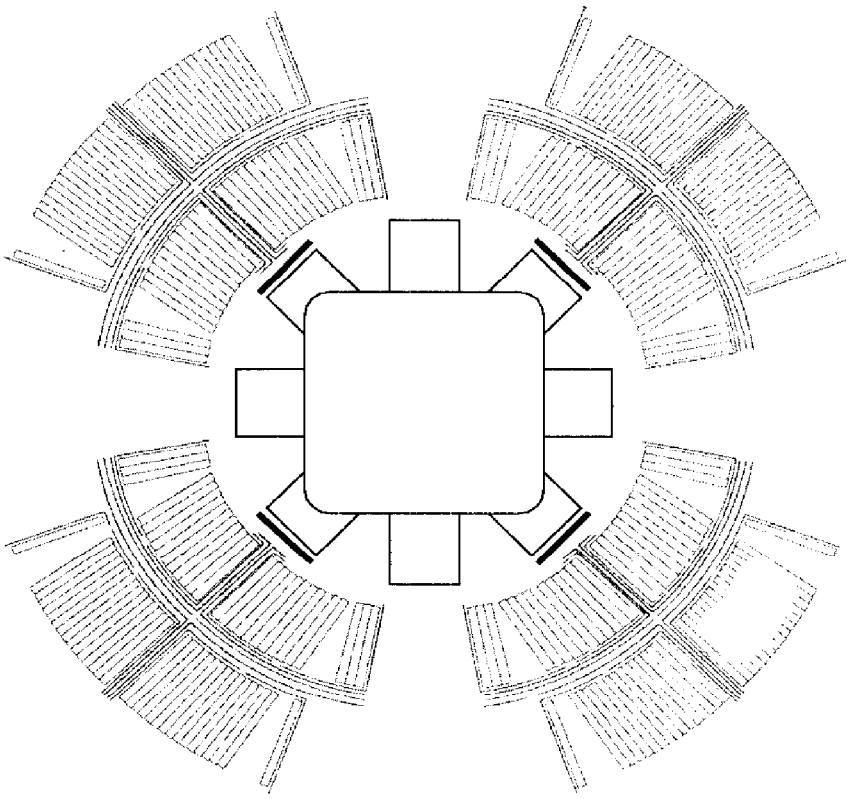
N/A _____
Technician(s) Date

4.6 Install the Coil per Figure in Step 2.2 in to Quadrant #1 Outer Coil as per the Rollover and Assembly Station Operating Procedure (OP-333505), using the Insertion/Extraction Fixture (MC-344719) as per the Insertion/Extraction Fixture Operating Procedure (OP-333504).

N/A _____
Technician(s) Date

4.7 Install the Coil per Figure in Step 2.2 in to Quadrant #2 Outer Coil as per the Rollover and Assembly Station Operating Procedure (OP-333505), using the Insertion/Extraction Fixture (MC-344719) as per the Insertion/Extraction Fixture Operating Procedure (OP-333504).

D Murcyk _____ 10-1-01
Technician(s) Date



Q1 35.873
Q2 35.884
Q3 35.873
Q4 35.870

4.8 Install the Coil per Figure in Step 2.2 in to Quadrant #3 Outer Coil as per the Rollover and Assembly Station Operating Procedure (OP-333505), using the Insertion/Extraction Fixture (MC-344719) as per the Insertion/Extraction Fixture Operating Procedure (OP-333504).

N/A
Technician(s) Date

X 4.9 Verify the Coils are properly installed per the engineers diagram in step 2.2 and that all Inner Lead End Keys are Coplanar.

Crew Chief 10/2/01
Date

4.10 Verify the Inner to Outer Coil lengths are acceptable.

Responsible Authority 10-2-01
Date

5.0 Assembly Inspection

X 5.1 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.).

Caution:

During testing, ensure that the test current is off and the disconnect status safe light is lit while connecting and disconnecting test leads from the Coil Assembly.

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	Pass	Fail
Nominal		240 mΩ to 265 mΩ	310 mΩ to 340 mΩ		
Quadrant 1	Inner	.2564 mΩ			
	Outer		.3184 mΩ		
Quadrant 2	Inner	.2574 mΩ			
	Outer		.3180 mΩ		
Quadrant 3	Inner	.2573 mΩ			
	Outer		.3184 mΩ		
Quadrant 4	Inner	.2573 mΩ			
	Outer		.3184 mΩ		

Inductance		Inner	Outer	Pass	Fail
Nominal		560 to 625 µH	1.120 to 1.17 mH		
Quadrant 1	Inner	1,038000 µH			
	Outer		1.49588 mH		
Quadrant 2	Inner	627,433 µH			
	Outer		1.0793 mH		
Quadrant 3	Inner	1,05888 µH			
	Outer		1.50243 mH		
Quadrant 4	Inner	972,489 µH			
	Outer		1.4881 mH		

Q-Factor		Inner	Outer	Pass	Fail
Nominal		3.30 to 3.75	4.80 to 5.85		
Quadrant 1	Inner	1.93			
	Outer		2.32		
Quadrant 2	Inner	~~2.023.5~~			
	Outer		~~2.42~~ 3.55		
Quadrant 3	Inner	2.02			
	Outer		2.42		
Quadrant 4	Inner	1.95			
	Outer		2.40		

Inspector

10/2/01
Date

NOTE: Q2 HAS NO TAP WIRE, THAT'S WHY IT'S DIFFERENT THAN THE OTHER 3 QUADRANTS!
SNG 10/2/01

5.2 Check the readings in Step 5.1 for acceptability, consistency and compare the readings to the Inspection Traveler Readings. Verify the Coil Positioning (Quadrant to Quadrant, and Inner to Outer) is acceptable. Approved for next major assembly procedure.

Responsible Authority/Physicist

10-2-01
Date

6.0 Splice Joints

6.1 Using the Soldering Jig (MD-344703), Kester Flux (MC-106761) and 1 layer 4.5" of 5 mil Kester Solder tape (MA-344821) or equivalent, position the Quadrant #1 Leads into the soldering jig, attach the Leads from the jig to the Soldering Station Controller.

N/A
Technician(s) Date

6.2 Set temperature controllers to 550°F (288 °C) and monitor temperature. When the Soldering Fixture attains 550°F (288 °C) shut down the soldering station and allow the Conductor to cool. Once the Conductor has cooled, remove the soldering jig. Using Scotch Brite 7447 (Fermi stock 1202-2020) or equivalent, clean the area that has just been soldered.

N/A
Technician(s) Date

6.3 Install the Quadrant #1 Outer Lead End Keys Parts C, D and E (MA-369646/MA-369647/MA-369648).

N/A
Technician(s) Date

6.4 Modify Preform Length as needed to fit flush to –1/16", inside of the Lead End Outer Keys.

N/A
Technician(s) Date

6.5 Insulate the bare areas of the Quadrant #1 Conductor as per the Inner Insulated Cable Assembly (MB-369691), stopping at the end of the Splice.

N/A
Technician(s) Date

6.6 Install the Voltage Tap Iors for Quadrant #1 per Outer Coil Voltage Tap Drawing (MD-369584).

N/A
Technician(s) Date

X 6.7 Verify the Quadrant #1 Outer Lead End Keys and the Inner Lead End Key are coplanar ± 1/32".

N/A
Crew Chief Date

6.8 Using the Soldering Jig (MD-344703), Kester Flux (MC-106761) and 1 layer 4.5" of 5 mil Kester Solder tape (MA-344821) or equivalent, position the Quadrant #2 Leads into the soldering jig, attach the Leads from the jig to the Soldering Station Controller.

Technician(s) Date 10-2-01

6.9 Set temperature controllers to 550°F (288 °C) and monitor temperature. When the Soldering Fixture attains 550°F (288 °C) shut down the soldering station and allow the Conductor to cool. Once the Conductor has cooled, remove the soldering jig. Using Scotch Brite 7447 (Fermi stock 1202-2020) or equivalent, clean the area that has just been soldered.

Technician(s) Date 10-2-01

6.10 Install the Quadrant #2 Outer Lead End Keys Parts C, D and E (MA-369646/MA-369647/MA-369648).

Technician(s) Date 10-2-01

6.11 Modify Preform Length as needed to fit flush to –1/16", inside of the Lead End Outer Keys.

Technician(s) Date 10-2-01

6.12 Insulate the bare areas of the Quadrant #2 Conductor as per the Inner Insulated Cable Assembly (MB-369691), stopping at the end of the Splice.

Technician(s) Date 10-2-01

6.13 Install the Voltage Tap Iors for Quadrant #2 per Outer Coil Voltage Tap Drawing (MD-369584).

Technician(s) Date 10-2-01

X 6.14 Verify the Quadrant #2 Outer Lead End Keys and the Inner Lead End Key are coplanar ± 1/32".

Crew Chief Date 10/2/01

6.15 Using the Soldering Jig (MD-344703), Kester Flux (MC-106761) and 1 layer 4.5" of 5 mil Kester Solder tape (MA-344821) or equivalent, position the Quadrant #3 Leads into the soldering jig, attach the Leads from the jig to the Soldering Station Controller.

N/A
Technician(s) Date

6.16 Set temperature controllers to 550°F (288 °C) and monitor temperature. When the Soldering Fixture attains 550°F (288 °C) shut down the soldering station and allow the Conductor to cool. Once the Conductor has cooled, remove the soldering jig. Using Scotch Brite 7447 (Fermi stock 1202-2020) or equivalent, clean the area that has just been soldered.

N/A
Technician(s) Date

6.17 Install the Quadrant #3 Outer Lead End Keys Parts C, D and E (MA-369646/MA-369647/MA-369648).

N/A
Technician(s) Date

6.18 Modify Preform Length as needed to fit flush to –1/16", inside of the Lead End Outer Keys.

N/A
Technician(s) Date

6.19 Insulate the bare areas of the Quadrant #3 Conductor as per the Inner Insulated Cable Assembly (MB-369691), stopping at the end of the Splice.

N/A
Technician(s) Date

6.20 Install the Voltage Tap Iors for Quadrant #3 per Outer Coil Voltage Tap Drawing (MD-369584).

N/A
Technician(s) Date

X 6.21 Verify the Quadrant #3 Outer Lead End Keys and the Inner Lead End Key are coplanar ± 1/32".

N/A
Crew Chief Date

6.22 Using the Soldering Jig (MD-344703), Kester Flux (MC-106761) and 1 layer 4.5" of 5 mil Kester Solder tape (MA-344821) or equivalent, position the Quadrant #4 Leads into the soldering jig, attach the Leads from the jig to the Soldering Station Controller.

N/A
Technician(s) Date

6.23 Set temperature controllers to 550°F (288 °C) and monitor temperature. When the Soldering Fixture attains 550°F (288 °C) shut down the soldering station and allow the Conductor to cool. Once the Conductor has cooled, remove the soldering jig. Using Scotch Brite 7447 (Fermi stock 1202-2020) or equivalent, clean the area that has just been soldered.

N/A
Technician(s) Date

6.24 Install the Quadrant #4 Outer Lead End Keys Parts C, D and E (MA-369646/MA-369647/MA-369648).

N/A
Technician(s) Date

6.25 Modify Preform Length as needed to fit flush to –1/16", inside of the Lead End Outer Keys.

N/A
Technician(s) Date

6.26 Insulate the bare areas of the Quadrant #4 Conductor as per the Inner Insulated Cable Assembly (MB-369691), stopping at the end of the Splice.

N/A
Technician(s) Date

6.27 Install the Voltage Tap Iors for Quadrant #4 per Outer Coil Voltage Tap Drawing (MD-369584).

N/A
Technician(s) Date

X 6.28 Verify the Quadrant #4 Outer Lead End Keys and the Inner Lead End Key are coplanar ± 1/32".

N/A
Crew Chief Date

7.0 Return End Key Modification

7.1 Shim the Outer Return End Keys as needed using Kapton Tape till the Keys are coplanar ± 1/32".

Technician(s) _____ Date 10-2-01

7.2 Measure the distance from the Outer Return End Key to the End of the Mandrel for each of the coils and record below. Verify the Outer Return End Keys are coplanar with the other Outer Return End Keys ± 1/32".

Quadrant 1: 31.283

Quadrant 2: 31.267

Quadrant 3: 31.264

Quadrant 4: 31.285

Technician(s) _____ Date 10-2-01

7.3 Scribe, remove and cut the Modified Inner Return End Keys (MA-369098).

Note(s):

Ensure the Keys are marked with the serial number of the coil.

Technician(s) _____ Date 10-2-01

7.4 Reinstall the Modified Inner Return End Keys (MD-369098).

Technician(s) _____ Date 10-2-01

7.5 Measure the distance between the Modified Inner Return End Keys and the end of the Inner Saddle, and the Outer Return End Key and the end of the Inner Saddle. Calculate the difference in the Inner Return End Keys and the Outer Return End Keys.

	Inner		Outer		Difference
Quadrant #1	32.481	-	32.465	=	.016
Quadrant #2	32.460	-	32.451	=	.009
Quadrant #3	32.460	-	32.444	=	.016
Quadrant #4	32.480	-	32.468	=	.012

Technician(s) _____ Date 10-2-01

X 7.6 Verify the Inner Return End Key and the Outer Return End Keys are co-planer ± 1/32".

Crew Chief — Date: 10/3/01

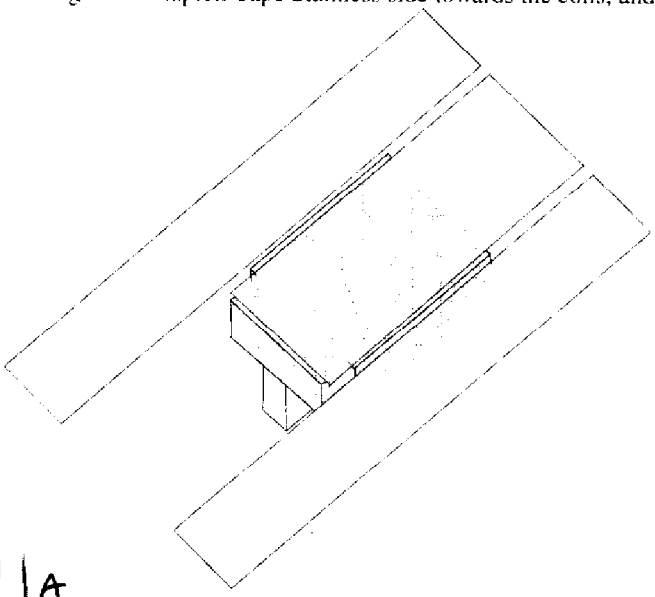
STOP

7.7 Verify the four Splices are acceptable. Verify the Inner Return End Key and the Outer Return End Keys are acceptable. Approved to continue with processing.

Responsible Authority/Physicist — Date: 10-3-01

8.0 Ground Wrap and Quench Protection Heater Installation for Quadrant #1

8.1 Clean the Quench Protector Heaters (MD-369619) (Qty 2) for Quadrant #1-2 and Quadrant #4-1 with Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Quench Protector Heaters (MD-369619) (Qty 2) on Quadrant #1-2 and Quadrant #4-1 using .5 mil Kapton Tape Stainless side towards the coils, and Copper side out.

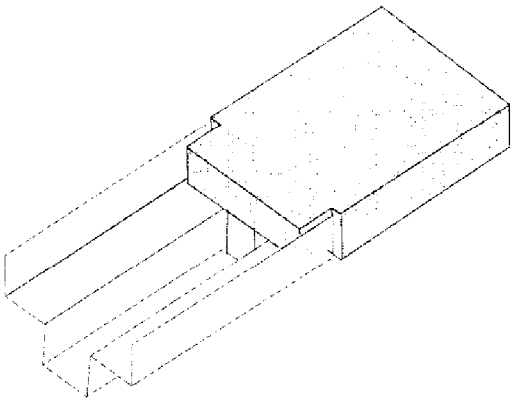


N/A
Technician(s) _____ Date _____

8.2 Clean and modify the Pole Ground Wrap 1 (MC-369623) for Quadrant #1 with Isopropyl Alcohol (Fermi Stock 1920-0300) and Lint Free Wipers (Fermi-Stock 1660-0150) or equivalent. Install the Pole Ground Wrap 1 (MC-369623) on Quadrant #1. See Coil Insulation Assembly (MC-369582).

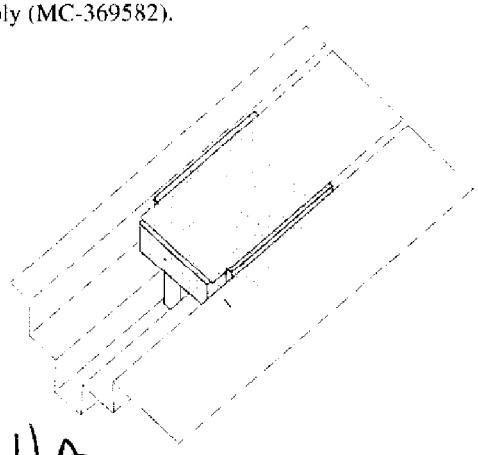
Note(s):

Ensure the Ground Wrap is inserted between the Key and Coil for .3/8"



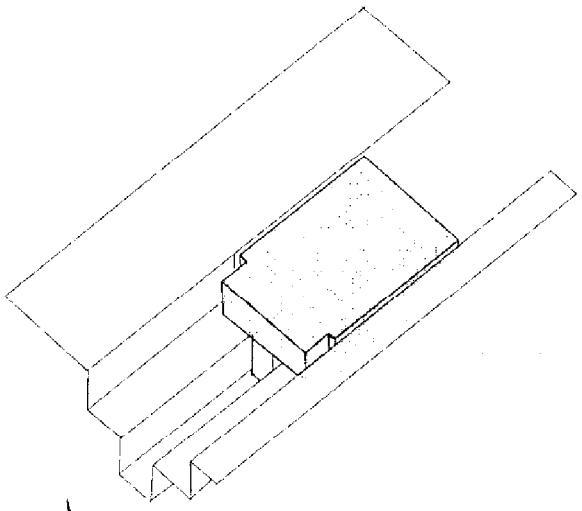
N/A
Technician(s) _____ Date _____

8.3 Clean and modify the Pole Ground Wrap 2 (MC-369582) for Quadrant #1 using Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Pole Ground Wrap 2 (MC-369624) on Quadrant #1 to extend to back of Saddles. See Coil Insulation Assembly (MC-369582).



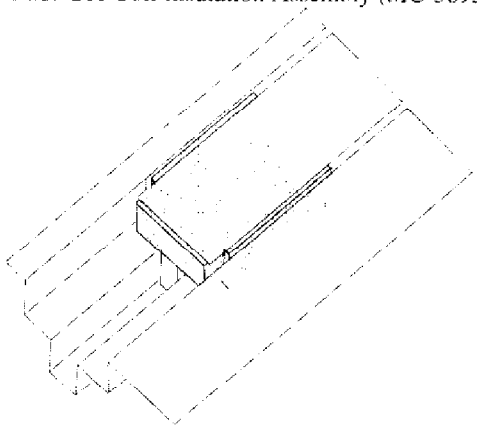
N/A
Technician(s) _____ Date _____

8.4 Clean and modify the Pole Ground Wrap 3 (MC-369625) for Quadrant #1 with Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Pole Ground Wrap 3 (MC-369625) on Quadrant #1. See Coil Insulation Assembly.



N/A
Technician(s) _____ Date _____

8.5 Clean the Outer Coil Heater Strip Filler (MC-369632) (Qty 4) for Quadrant #1 with Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Outer Coil Heater Strip Filler (MC-369632) (Qty 4) on Quadrant #1 2 at the Lead End and 2 at the Return End. See Coil Insulation Assembly (MC-369582).

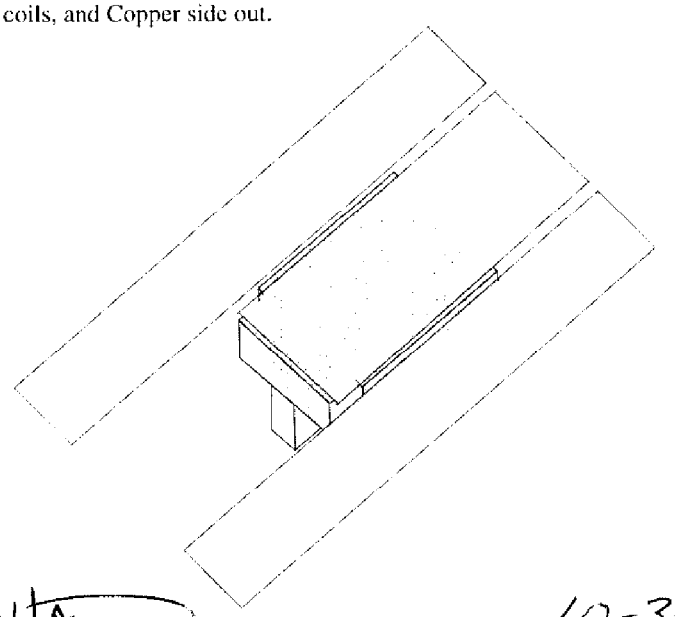


N/A
Technician(s)

Date

9.0 Ground Wrap and Quench Protection Heater Installation for Quadrant #2

9.1 Clean the Quench Protector Heaters (MD-369619) for Quadrant #2-3 with Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Quench Protector Heaters (MD-369619) on Quadrant #2-3 using .5 mil Kapton Tape Stainless side towards the coils, and Copper side out.

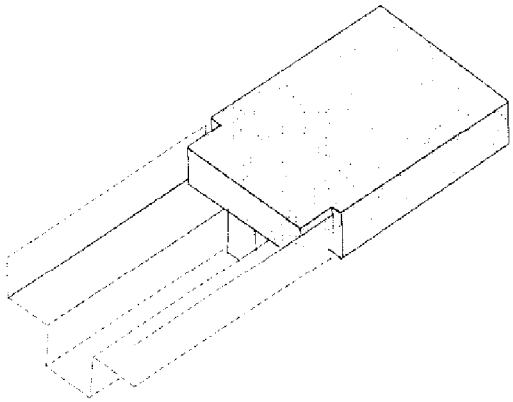


Technician(s) Date 10-3-01

9.2 Clean and modify the Pole Ground Wrap 1 (MC-369623) for Quadrant #2 with Isopropyl Alcohol (Fermi Stock 1920-0300) and Lint Free Wipers (Fermi-Stock 1660-0150) or equivalent. Install the Pole Ground Wrap 1 (MC-369623) on Quadrant #2. See Coil Insulation Assembly (MC-369582).

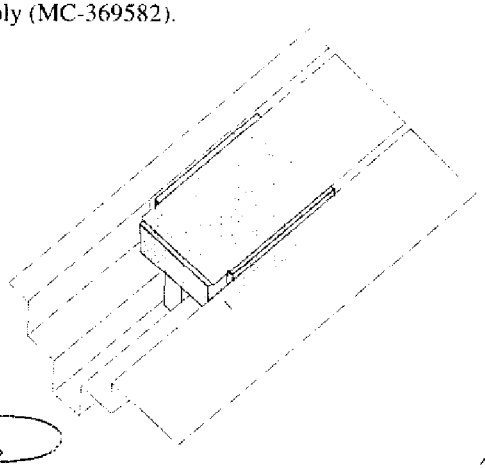
Note(s):

Ensure the Ground Wrap is inserted between the Key and Coil for .3/8"



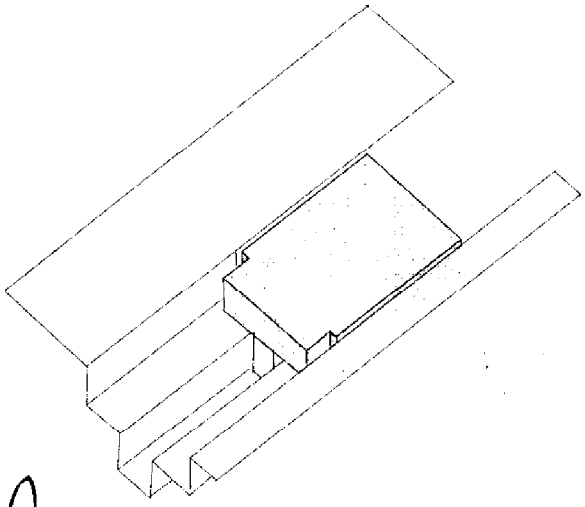
Technician(s) Date 10.3-01

9.3 Clean and modify the Pole Ground Wrap 2 (MC-369582) for Quadrant #2 using Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Pole Ground Wrap 2 (MC-369624) on Quadrant #2 to extend to back of Saddles. See Coil Insulation Assembly (MC-369582).



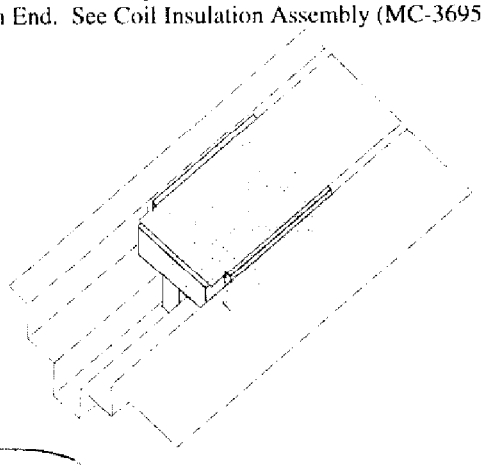
Technician(s) 10-3-01 Date

9.4 Clean and modify the Pole Ground Wrap 3 (MC-369625) for Quadrant #2 with Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Pole Ground Wrap 3 (MC-369625) on Quadrant #2. See Coil Insulation Assembly.



Technician(s) 10/3/01 Date

9.5 Clean the Outer Coil Heater Strip Filler (MC-369632) (Qty 4) for Quadrant #2 with Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Outer Coil Heater Strip Filler (MC-369632) (Qty 4) on Quadrant #2, 2 at the Lead End and 2 at the Return End. See Coil Insulation Assembly (MC-369582).

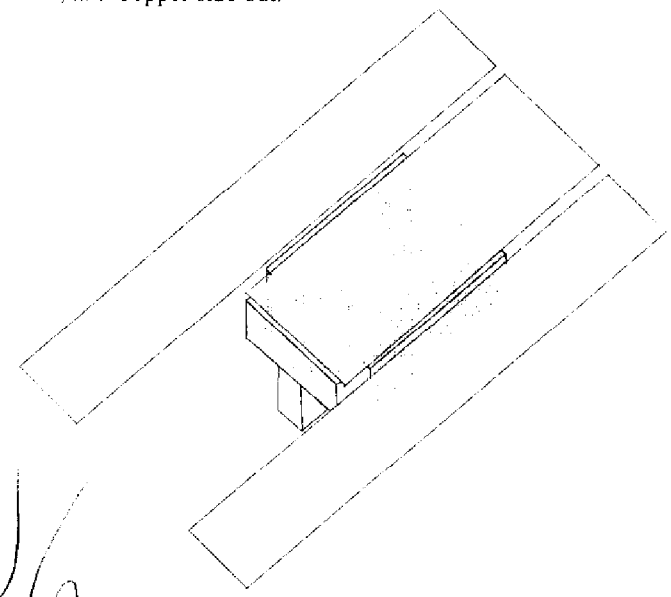


Technician(s)

10-3-01
Date

10.0 Ground Wrap and Quench Protection Heater Installation for Quadrant #3

10.1 Clean the Quench Protector Heaters (MD-369619) for Quadrant #3-4 with Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Quench Protector Heaters (MD-369619) on Quadrant #3-4 using .5 mil Kapton Tape Stainless side towards the coils, and Copper side out.



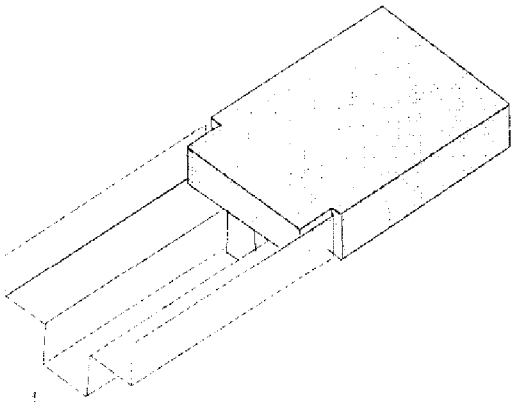
N/A

Technician(s) _____ Date _____

10.2 Clean and modify the Pole Ground Wrap 1 (MC-369623) for Quadrant #3 with Isopropyl Alcohol (Fermi Stock 1920-0300) and Lint Free Wipers (Fermi-Stock 1660-0150) or equivalent. Install the Pole Ground Wrap 1 (MC-369623) on Quadrant #3. See Coil Insulation Assembly (MC-369582).

Note(s):

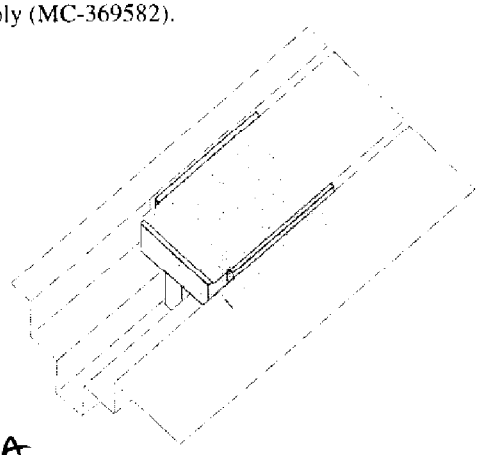
Ensure the Ground Wrap is inserted between the Key and Coil for .3/8"



N/A

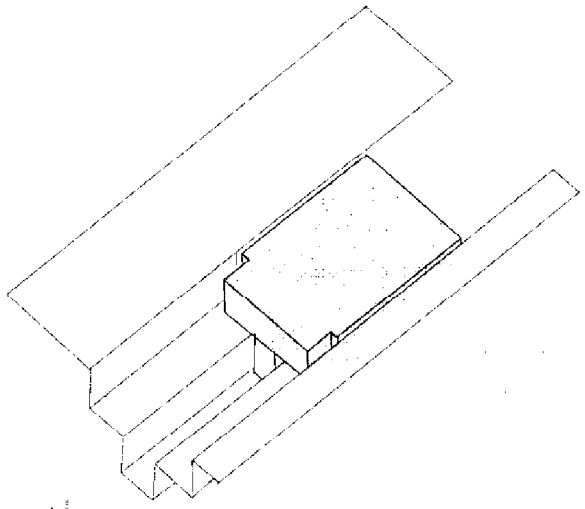
Technician(s) _____ Date _____

10.3 Clean and modify the Pole Ground Wrap 2 (MC-369582) for Quadrant #3 using Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Pole Ground Wrap 2 (MC-369624) on Quadrant #3 to extend to back of Saddles. See Coil Insulation Assembly (MC-369582).



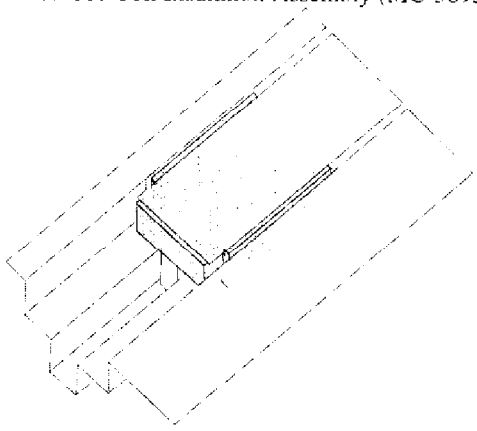
N/A
Technician(s) _____ Date _____

10.4 Clean and modify the Pole Ground Wrap 3 (MC-369625) for Quadrant #3 with Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Pole Ground Wrap 3 (MC-369625) on Quadrant #3. See Coil Insulation Assembly.



N/A
Technician(s) _____ Date _____

10.5 Clean the Outer Coil Heater Strip Filler (MC-369632) (Qty 4) for Quadrant #3 with Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Outer Coil Heater Strip Filler (MC-369632) (Qty 4) on Quadrant #3 2 at the Lead End and 2 at the Return End. See Coil Insulation Assembly (MC-369582).



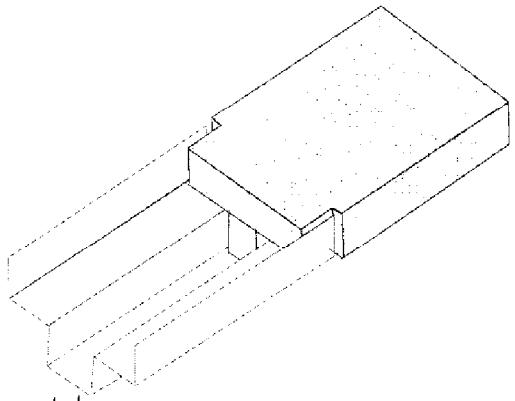
N/A

Technician(s) _____ Date _____

11.0 Ground Wrap and Quench Protection Heater Installation for Quadrant #4

11.1 Clean and modify the Pole Ground Wrap 1 (MC-369623) for Quadrant #4 with Isopropyl Alcohol (Fermi Stock 1920-0300) and Lint Free Wipers (Fermi-Stock 1660-0150) or equivalent. Install the Pole Ground Wrap 1 (MC-369623) on Quadrant #4. See Coil Insulation Assembly (MC-369582).

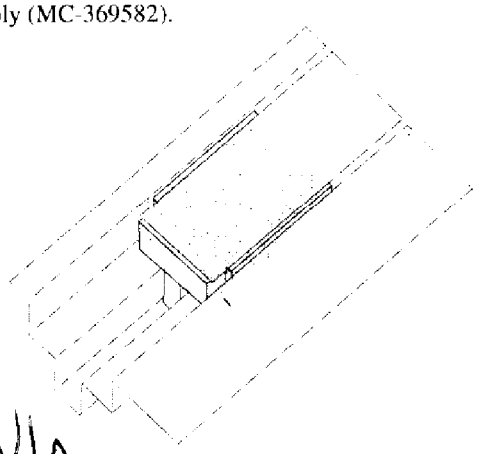
Note(s):
Ensure the Ground Wrap is inserted between the Key and Coil for .3/8"



N/A

Technician(s) _____ Date _____

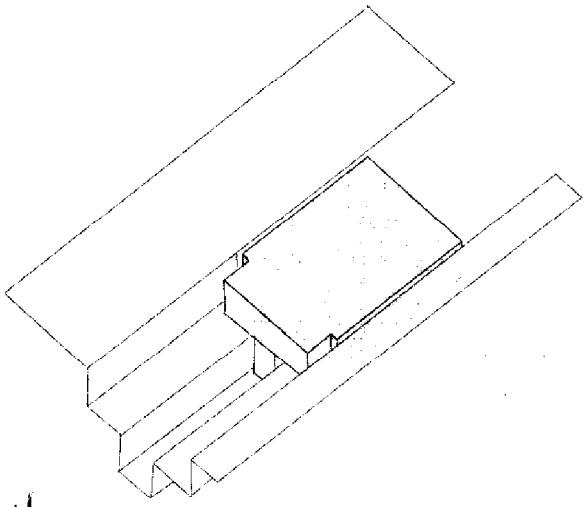
11.2 Clean and modify the Pole Ground Wrap 2 (MC-369582) for Quadrant #4 using Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Pole Ground Wrap 2 (MC-369624) on Quadrant #4 to extend to back of Saddles. See Coil Insulation Assembly (MC-369582).



N/A

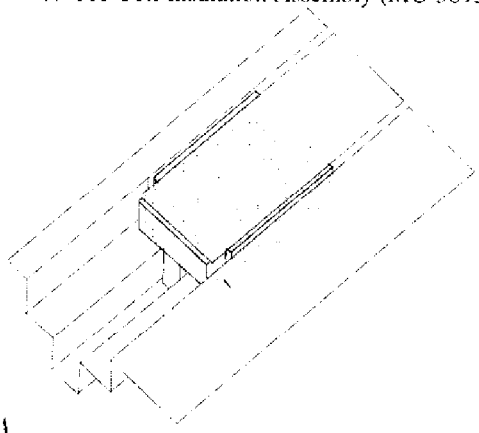
Technician(s) _____ Date _____

11.3 Clean and modify the Pole Ground Wrap 3 (MC-369625) for Quadrant #4 with Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Pole Ground Wrap 3 (MC-369625) on Quadrant #4. See Coil Insulation Assembly.



N/A
Technician(s) _____ Date _____

11.4 Clean the Outer Coil Heater Strip Filler (MC-369632) (Qty 4) for Quadrant #4 with Isopropyl Alcohol (Fermi stock 1920-0300) and Lint Free Wipers (Fermi stock 1660-0150) or equivalent. Install the Outer Coil Heater Strip Filler (MC-369632) (Qty 4) on Quadrant #4 2 at the Lead End and 2 at the Return End. See Coil Insulation Assembly (MC-369582).



N/A
Technician(s) _____ Date _____

12.0 Electrical Inspection

12.1 Apply Shrink-Wrap Mylar (MC-106937) on the entire length of the Collared Coil Assembly.

D Nunez — Technician(s)

10-3-01 — Date

12.2 Shim the Return End Saddles coplanar ± 1/32".

Note(s):

Use **Teflon Tape on the Saddles and Green Putty (Green Putty is temporary, and will be removed after Collaring).**

Technician(s)

10-3-01 — Date

X 12.3 Verify the Saddles are coplanar ± 1/32".

Crew Chief

10/4/01 — Date

X 12.4 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	.257.0 mΩ				
	Outer		.3190 mΩ			
	Total			.5760 mΩ		
Quadrant 2	Inner	.2579 mΩ				
	Outer		.3180 mΩ			
	Total			.5758 mΩ		
Quadrant 3	Inner	.2577 mΩ				
	Outer		.3187 mΩ			
	Total			.5764 mΩ		
Quadrant 4	Inner	.2577 mΩ				
	Outer		.3189 mΩ			
	Total			.5765 mΩ		

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	1.25573 µH				
	Outer		1.70617 mH			
	Total			2.96182 mH		
Quadrant 2	Inner	1.24154 µH				
	Outer		1.68808 mH			
	Total			2.93017 mH		
Quadrant 3	Inner	1.25579 µH				
	Outer		1.70098 mH			
	Total			2.95631 mH		
Quadrant 4	Inner	1.25861 µH				
	Outer		1.70645 mH			
	Total			2.96450 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	3.90				
	Outer		4.06			
	Total			4.00		
Quadrant 2	Inner	3.94				
	Outer		4.05			
	Total			4.01		
Quadrant 3	Inner	3.83				
	Outer		4.01			
	Total			3.94		
Quadrant 4	Inner	3.83				
	Outer		4.04			
	Total			3.96		

D Mungyt
Inspector

10-4-01
Date

Electrical Test	Limit	Actual Measurement	Pass	Fail
Heater Strips 1/2 Resistance	9.20 to 9.60 Ω	9.232 Ω	✓	
Heater Strips 2/3 Resistance	9.20 to 9.60 Ω	9.212 Ω	✓	
Heater Strips 3/4 Resistance	9.20 to 9.60 Ω	9.256 Ω	✓	
Heater Strips 4/1 Resistance	9.20 to 9.60 Ω	9.201 Ω	✓	

Voltage Taps	Iors (ramp splice) 1/8 Coil Taps	Pass	Fail
Quadrant 1	.2110 mV		
Quadrant 2	.2061 mV		
Quadrant 3	.2088 mV		
Quadrant 4	.2068 mV		

Inspector

10-4-01
Date

STOP

12.5 Check the readings in Step 12.4 for acceptability, consistency and compare to the readings to step 5.1. Approved for next major assembly procedure.

Responsible Authority/Physicist

10-4-01
Date

13.0 Production Complete

13.1 Process Engineering verify that the LHC Coil Insulation and Assembly Traveler (333494) 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

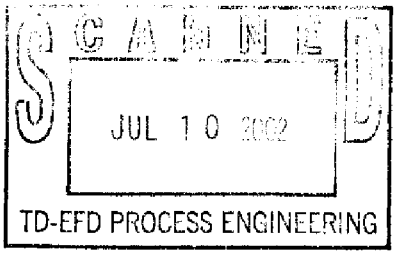
Date

Traveler Title:	Specification No:	Revision:	DR No:
LHC Collaring and Keying Traveler	5520-TR-333495	B	HGQ-0259

Step No:	Drawing No:	Routing Form No:	Serial No:
4.3	ME-369581		MQXBC-002-1

Discrepancy Description:

Assembly developed a quadrant 2 coil to collaring tooling short upon completion of the massaging of collars for keying. Short appeared after completion of the 1800 pump psi massage and prior to beginning of partial insertion of tapered keys.



Originator: Jim Rife

Date: 10/9/2001

Cause of Nonconformance:

Small piece of weld slag between ground wrap and collars. See attached e-mail.

Responsible Authority: Rodger Bossert

Date: 10/9/2001

Disposition:

(Re-issue entire 333494 traveler omitting steps not necessary or previously done and are acceptable)
(The following is an attached e-mail from Rodger Bossert addressing this issue) (Entered in by John Szostak - 7/10/02)
Jim Rife & crew were "massaging" MQXB02 yesterday morning (Wednesday, Sept. 26, 2001). About halfway through the first massage, the resistance monitor showed a change in Q2 resistance, the kind seen when there is a short from coil to mandrel. This happened as they were removing the hydraulic pressure from one section, and did not go away after the pressure had been completely removed. They verified the "coil to mandrel short" by checking for, and getting, electrical continuity between the Q2 coils and the "end tooling", which is in electrical contact with the mandrel. They then raised the magnet up from the pit, and removed the lamination packs that they were pressing when the short occurred. They found, between the inside surface of the collar laminations and the outside radial surface of the outer coil, a small (about 1/32 inch diameter) ball, what looks like weld slag. It was situated azimuthally about 1 cm toward the midplane from the outer coil pole. The ball had obviously done some damage to the ground wrap. Working inward from the collars to the outer surface of the outer coil, we have, in order, two layers of 5 mil ground wrap, then a strip heater, which consists of two layers of 4 mil kapton with a 1 mil metal element sandwiched in the middle, then the coil. The ball had punctured a hole into the first (outermost) layer of ground wrap. It happened, by coincidence, to lay exactly in the longitudinal crack between the two halves of the second layer of ground wrap. It then had completely penetrated the outside 4 mil layer covering the heater, exposing and indenting, but not punching a hole in, the metal element. They removed the foreign piece, put the collar packs back on, and massaged again. The short was gone. It seemed pretty clear that this was the cause of the short, since it was

Responsible Authority: Rodger Bossert

Date: 10/9/2001

Corrective Action to Prevent Recurrence:

(The following is an attached e-mail from Rodger Bossert addressing this issue) (Entered in by John Szostak - 7/10/02)
Jim Rife & crew were "massaging" MQXB02 yesterday morning (Wednesday, Sept. 26, 2001). About halfway through the first massage, the resistance monitor showed a change in Q2 resistance, the kind seen when there is a short from coil to mandrel. This happened as they were removing the hydraulic pressure from one section, and did not go away after the pressure had been completely removed. They verified the "coil to mandrel short" by checking for, and getting, electrical continuity between the Q2 coils and the "end tooling", which is in electrical contact with the mandrel. They then raised the magnet up from the pit, and removed the lamination packs that they were pressing when the short occurred. They found, between the inside surface of the collar laminations and the outside radial surface of the outer coil, a small (about 1/32 inch diameter) ball, what looks like weld slag. It was situated azimuthally about 1 cm toward the midplane from the outer coil pole. The ball had obviously done some damage to the ground wrap. Working inward from the collars to the outer surface of

Responsible Authority: Rodger Bossert

Date: 10/9/2001

Corrective Action/Disposition Verified By: Rodger Bossert

Date: 10/9/2001

Will Configuration be affected?: ☐ YES ☑ NO

Identified problem area:

☐ Material ☐ Manpower ☐ Method ☐ Machine ☑ Measurement

Reviewed By: Bob Jensen

Date: 11/20/2001

1) Traveler Title:	2) Specification No.:	3) Revision:	4) DR No.:
LHC Collaring & Keying Traveler	333495	B	HGQ-0259

5) Step No.:	6) Drawing No. & Revision:	7)Routing No.:	8)Component/Item/Batch/Lot No.:	9)Serial No.:
4.3	ME-369581		MQXBC002	MQXBC002

10) Nonconformance Description by First Hand Observer: ☐ Class I ☑ Class II

Assembly developed a quadrant 2 coil to collaring tooling short upon completion of the massaging of collars for keying. Short appeared after completion of the 1800 pump psi massage and prior to begining of partial insertion of tappered keys.

11) Name: Jim Rife Date: 10/9/2001

12) Cause of Nonconformance:

Small piece of weld slag between ground wrap and collars. See attached email

13) Responsible Authority Rodger Burt Date: 10/9/2001

14) Disposition:

See attached email.

13) Responsible Authority Rodger Burt Date: 10/9/01

15) Corrective Action to Prevent Recurrence: TRR#1258

See attached email.

13) Responsible Authority Rodger Burt Title: Engineer Date: 10/9/01

16) Corrective Action/Disposition Verified By:

Rodger Burt

13) Responsible Authority Date: 10/9/01

[ ] Class I [ ] Class II

Will Configuration be affected? [ ] Yes [X] No

17) Reviewed By:

Bob Jungst 11/20/01

Process Engineering Manager Date:

18) ☐ Material ☐ Manpower ☐ Method ☐ Machine ☒ Measurement

Process Engineering determine (identify), appropriate problem area and check.

Instructions for the completion of the Discrepancy Report Form

Definition:
>>Discrepancy Report - A form used to report all Class I & Class II problems (Discrepancies).

Process Engineering Responsibility:
>> Process Engineering - Maintains and Controls the Group's Discrepancy Report and Control Log.

1. Traveler Title - Enter the title of the Traveler at the point the Discrepancy was found.
2. Enter the Specification Number in place at the time of the Discrepancy.
3. Enter the Revision in place at the time of the Discrepancy.
4. DR Number - Enter the next number from the control log that is maintained by Process Engineering.
5. Step No. - Record the step in the Traveler where the Discrepancy was found or the process stopped. Attach a copy of traveler page (s) or the process description as appropriate or required to clarify the condition.
6. Drawing No. & Revision - Reference the applicable drawing that describes the item or condition.
7. If part is defective, record Routing No. from Parts Kit.
8. Enter - The Component/Item/Batch/Lot Number - (an identification Number assigned to the Item).
9. Enter - The Serial Number - (an identification Number assigned to the Item).
10. Nonconformance Description by First Hand Observer - Enter a brief and concise description of those actions, conditions, or facts that result in a nonconforming condition along with the reason it is out of specification. This is done by the person that observed the condition and is assisted by a Process Engineering Technician or Production Supervisor.
11. Enter Name, Title, Date - the First Hand Observer, his /her job title and the date the condition was observed.
12. Cause of Nonconformance - Enter the agreed event or condition that rendered the item unacceptable for use. If unable to determine the cause at this time, state "Unknown" with an explanation.
13. Responsible Authority - That person in charge of the area or activity in question states the cause and disposition of the nonconforming condition and verifies that the Corrective Action and Disposition have been completed. Before closing the report he determines if the configuration of the component/item is effected and if the nonconforming condition is Class I or II.

    CONFIGURATION - The physical and functional characteristics of a Component/Item, including the materials, parts and limit criteria that are "frozen" in the design documents.

    CLASS I - A major problem that affects configuration, performance, form, fit, function, reliability or safety, significant cost or schedule increase.

    CLASS II - A minor problem that is not Class I, but can be eliminated by approved repair or rework that when completed in an acceptable manner will bring the nonconforming condition into compliance with the design requirements.

14. Disposition - A plan by the Responsible Authority that will render the item or condition acceptable for use. This may be use-as-is, rework, repair, replace, substitute or scrap along with details.
15. Corrective Action to Prevent Recurrence - Those actions necessary to correct, minimize or eliminate the cause from repeating itself in the process, work instructions, work practices, inspections, drawing, tools, equipment or materials, etc.
16. Corrective Action/Disposition Verified - To be signed after the Cause, Disposition and Corrective Action to Prevent Recurrence have been put into place or completed.
17. Reviewed By: - The Process Engineering Manager performs a review of the report to assure proper completion; that the Corrective Action to Prevent Recurrence and Disposition have been completed and are acceptable.
18. Process Engineering determine (identify), appropriate problem area.

Return-Path: <bossert@fnal.gov>
Received: from imapservera.fnal.gov ([131.225.9.7]) by imapservera.fnal.gov (Netscape Messaging Server 4.15) with SMTP id GKBRJR00.N0J; Thu, 27 Sep 2001 09:14:15 -0500
Received: from heffalump.fnal.gov ([131.225.9.20]) by imapservera.fnal.gov (NAVIEG 2.1 bld 63) with SMTP id M2001092709141526521 ; Thu, 27 Sep 2001 09:14:15 -0500
Received: from fnal.gov ([131.225.46.236]) by smtp.fnal.gov (PMDF V6.0-24 #37519) with ESMTP id <0GKB00JKZRJQTU@smtp.fnal.gov>; Thu, 27 Sep 2001 09:14:14 -0500 (CDT)
Date: Thu, 27 Sep 2001 09:26:24 -0500
From: Rodger Bossert <bossert@fnal.gov>
Subject: **MQXB02 Collaring Problems**
To: Kerby Jim <kerby@fnal.gov>
CC: "Cullen, Matt" <mcullen@popgtw.fnal.gov>, "Lamm, Mike" <lamm@fnal.gov>, Nobrega Fred <nobrega@fnal.gov>, "Rife, Jim" <jrife@fnal.gov>
Message-ID: <3BB33710.AA606E6A@fnal.gov>
MIME-version: 1.0
X-Mailer: Mozilla 4.77 [en] (Windows NT 5.0; U)
Content-type: text/plain; charset=iso-8859-1
Content-transfer-encoding: QUOTED-PRINTABLE
X-Accept-Language: en

Jim:

Jim Rife & crew were "massaging" MQXB02 yesterday (Wednesday, Sept 26) morning. About halfway through the first massage, the resistance monitor showed a change in Q2 resistance, the kind seen when there is a short from coil to mandrel. This happened as they were removing the hydraulic pressure from one section, and did not go away after the pressure had been completely removed. They verified the "coil to mandrel short" by checking for, and getting, electrical continuity between the Q2 coils and the "end tooling", which is in electrical contact with the mandrel.

They then raised the magnet up from the pit, and removed the lamination packs that they were pressing when the short occurred. They found, between the inside surface of the collar laminations and the outside radial surface of the outer coil, a small (about 1/32 inch diameter) ball, what looks like weld slag. It was situated azimuthally about 1 cm toward the midplane from the outer coil pole.

The ball had obviously done some damage to the ground wrap. Working inward from the collars to the outer surface of the outer coil, we have, in order, two layers of 5 mil ground wrap, then a strip heater, which consists of two layers of 4 mil kapton with a 1 mil metal element sandwiched in the middle, then the coil. The ball had punctured a hole into the first (outermost) layer of ground wrap. It happened, by coincidence, to lay exactly in the longitudinal crack between the two halves of the second layer of ground wrap. It then had completely penetrated the outside 4 mil layer covering the heater, exposing and indenting, but not punching a hole in, the metal element. They removed the foreign piece, put the collar packs back on, and massaged again. The short was gone.

It seemed pretty clear that this was the cause of the short, since it was found at the precise spot where the short occurred, and its removal caused the short to go away. But the puzzling question was, "why a coil to mandrel short, but not a coil to ground short?" You would expect the object to have caused a short between the collars and coil, or at least the collars and heater. Yet there was no continuity from Q2 coils to the collars.

One possible explanation was that the dent in the heater, and the subsequent pressure on the coils, caused the heater to be shorted to the coils. This explanation would also require that the heaters be shorted to the end tooling, which was possible if the heaters, where they are rolled up at the ends, were touching the tooling somewhere. This would look like a short between the end tooling and the coils, but the path would be through the heater.

To check this, we pressed on the exposed area of the heater (from the outside) with a metal probe, pushing it gently against the coil, connected the other leads of the meter to the coil leads, and checked for continuity (checking for continuity between the heater and the coil). We also checked for continuity between the heater and the end tooling, in the same way. In both cases, we got electrical continuity with the heater, confirming our hypothesis.

So we know we have a heater-to-coil short. Even though it is not a "hard short", when we massage, the magnet would almost certainly not pass a hipot after keying. We will need to remove the collar packs, replace the damaged heater and ground wrap section, and re-collar.

I am writing this Thursday morning, when they have already removed about 2/3 of the collar packs. A few minutes ago, Damon and Jamie showed me another, larger piece of apparent weld slag that they found in another part of the magnet, while removing the collar packs. There is no place where the ground insulation has been damaged, so this piece might have been lodged in one of the cooling holes between the packs.

This problem is not a major disaster for this magnet. We will lose one heater, a piece of ground wrap, and about 4 days time. But the larger issue is how to prevent this from happening again. Assuming we are right, and it is weld slag, I guess we will have to institute some much more rigorous inspection of the collar packs.

By the way, this may well have been the reason for the still-unresolved heater-to-ground short in P1.

Rodger