

**Fermi National Accelerator Laboratory  
 Batavia, IL 60510**

**LARGE HADRON COLLIDER  
 COLLARING & KEYING TRAVELER**

**Reference Drawing(s)  
 Collared Coil Assembly  
 ME-369581**

Project/Task Number: 300/1.1.1.6.2

Date Closed: 1/7/03

62  
~~60~~ Pages

Budget Code: 6PT

Project Code: ~~6PT~~ CMAS

Released by: [Signature]

Date: 9/29/01

Prepared by: M. Cullen, J. Larson

Magnet/Device Series: LQXB

Title	Signature	Date
TD / E&F Process Engineering	 Bob Jensen/Designee	9/11/01
TD / LHC Production Supervisor	 Jim Kelly/Designee	9-11-01
TD /LHC Production Engineer	 Rodger Bossert/Designee	9-11-01
TD / LHC Tooling Engineer	 John Carlson/Designee	9/11/01
TD / LHC Program Manager	 Jim Kelly/Designee	9/11/01

**Revision Page**

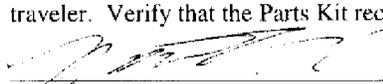
<b>Revision</b>	<b>Step No.</b>	<b>Revision Description</b>	<b>TRR No.</b>	<b>Date</b>
None	N/A	Initial Release	N/A	10/16/00
A	3.0	Modified the Lamination Packs and added Kapton.	1183	6/13/01
	4.0	Removed Strain Gauges		
	5.0	Added Electrical Limits		
B	5.0	Removed electrical limits, added engineer sign off.	1192	9/11/01
	5.0	Broke into three steps (5.0, 6.0, 7.0)		

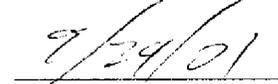
1.0 General Notes

- 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 as applicable.
- 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 List for the LHC Collared Coil Keying Traveler 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.

  
\_\_\_\_\_  
Process Engineering/Designee

  
\_\_\_\_\_  
Date

TRR# 1258

3.0 Collaring

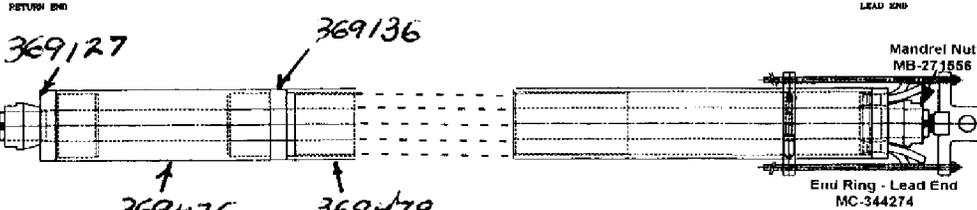
3.1 Clean all Mandrel hardware with Isopropyl Alcohol (Fermi stock 1920-0300) and Heavy Disposable Wipes (Fermi stock 1660-2600) or equivalent.

Technician(s)

Date

9-24-01

3.2 Install the Nuts and the Lifting Eye onto the Lead End of the Mandrel.



Technician(s)

Date

9-24-01

3.3 Lift vertically with the crane and transport the Collared Coil Assembly to the Keying Press and insert the Collared Coil Assembly into the Keying Press.

Technician(s)

Date

9/24/01

3.4 Machine the End Collar Lamination Packs (8) in accordance with the End Pack Modification Drawings (MX-XXXXXX).

Technician(s)

Date

9/25/01

3.5 Install the Return End Collar Lamination Packs with 5 mil self adhesive kapton on the Pole Piece side in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

Note(s):

Remove shrink-wrap Mylar in 3" sections to prevent the ground wrap from loosening during collaring.

Technician(s)

Date

9-25-01

3.6 Install the Collar Lamination Packs in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

Note(s):

Remove shrink-wrap Mylar in 3" sections to prevent the ground wrap from loosening during collaring.

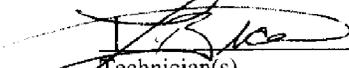
Technician(s)

Date

9-26-01

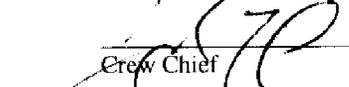
ALL ↓  
 - TRR NEEDED WITH DRAWING NUMBER  
 - TRR TO ADD STEP TO INSTALL NON-LEAD END HARDWARE.  
 - TRR MORE DETAILS TO THIS STEP? YES!  
 - NEED DRAWING NUMBER

- 3.7 Install the Modified Lead End Collar Lamination Packs with 5 mil self adhesive kapton on the Pole Piece side in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

  
\_\_\_\_\_  
Technician(s)

9-26-01  
Date

- 3.8 Verify the Lamination Packs are tight and in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

  
\_\_\_\_\_  
Crew Chief

9-26-01  
Date

4.0 Keying Procedure

**Note(s):**

**Operate the Press in accordance with the Operating Procedure (OP-333503)  
Monitor resistance of the magnet during the entire Collaring Procedure.  
Resistance change of no more than 3 mOhms is allowed.**

4.1 Massage the Collared Coil Assembly at 900-pump psi. from Lead End to Return End.

\_\_\_\_\_  
Technician(s)

\_\_\_\_\_  
Date

9-26-01

4.2 Massage the Collared Coil Assembly at 1800 pump psi from Return End to Lead End.

\_\_\_\_\_  
Technician(s)

\_\_\_\_\_  
Date

4.3 Partially insert Keys from the Lead End to Return End. Use 3000 pump psi main pusher pressure and 700-pump psi Key pusher pressure for this step.

**Note(s):**

**As needed modify the length of the keys 6" above the End of the Assembly to  
Ensure the final key is > 4" in length.  
Verify the Mandrel Nut is hand tight every 4 ft (four times) of Keying.  
Engage the Main Pushers, and then the Key Pushers, release the Main Pushers,  
and then the Key Pushers.**

\_\_\_\_\_  
Technician(s)

\_\_\_\_\_  
Date

4.4 Fully insert Keys from the Lead End to Return End. Use 4400 pump psi main pusher pressure and 2700-pump psi Key pusher pressure.

**Note(s):**

**Verify the Mandrel Nut is hand tight every 4 ft (four times) of Keying.  
Engage the Main Pushers, and then the Key Pushers, release the Main Pushers,  
and then the Key Pushers.**

\_\_\_\_\_  
Technician(s)

\_\_\_\_\_  
Date

X 4.5 While Lowering and Raising the Coil Assembly, visually inspect Keys to verify they are fully inserted.

\_\_\_\_\_  
Inspector

\_\_\_\_\_  
Date

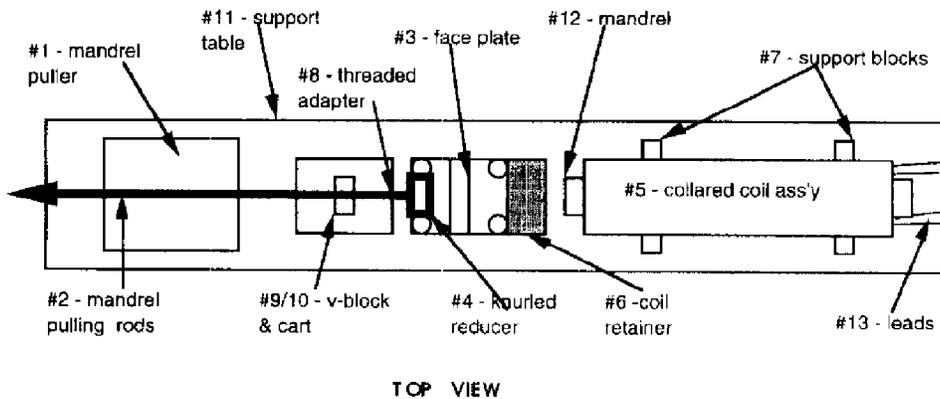
4.6 Bring the Collared Coil Assembly horizontal using Approved and Appropriate procedures

\_\_\_\_\_  
Technician(s)

\_\_\_\_\_  
Date

*DRH*  
*Ø 25.6*

5.0 Pulling the Mandrel



**Note(s):**

**Mandrel should be pulled out from return end of Collared Coil Assembly. Ensure that the Mandrel is kept in the correct radial position with respect to coils during extraction by inserting Mandrel into holding tooling (MC-344284) and Collar Laminations into Cradles (MD-344281)**

- 5.1 The Mandrel pulling rods (2) are to be picked up by the crane and pushed into the Mandrel Puller (1) until they click into the groove. The rods should be about 6" from the face plate (3). To displace the weight of the rods, a cart (9) with a V block (10) shall be used to support the pulling rods.
- 5.2 The Collared Coil Assembly (5) shall then be picked up with the crane using two slings so it remains level. It is then placed on the support blocks (7) so the coil retainer (6) is flush against the face plate (3).
- 5.3 The knurled reducer (4) is then screwed into the Mandrel (12) so the threaded adapter (8) can be screwed from the rods (2) to the reducer (4).
- 5.4 The Mandrel Puller (1) shall be warmed up about 20-30 minutes before pulling the Mandrel (12). The crane shall also be left on the slings with the Collared Coil Assembly during the pulling process.
- 5.5 Leads (13) shall be secured (cable tied) so they are out of the way during the process.

*[Signature]*  
 \_\_\_\_\_  
 Technician(s)

10/15/01  
 \_\_\_\_\_  
 Date

6.0 Final Inspection

- X 6.1 Perform an electrical inspection on each of the individual Inner and Outer Coils, Quadrants and Heaters. Refer to the Valhalla and Leader Free Standing Coil Measurement Procedure (ES-292306).

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 the disconnect status safe light is lit while connecting and disconnecting test leads from the Coil Assembly.

Valhalla 4300B settings:

Power must be on for 30 minutes before testing.

TRR  
 #1516

Test Current	_____	Off
Power	_____	On
Full Scale Voltage	_____	<del>20mV</del> 2V
Amp Selector Knob	_____	1 A
Temperature Compensator	_____	On
Test Current	_____	On (testing)

Hp 4263B:

Function	_____	"Ls-Q" selected
Freq	_____	1 KHz

Record the Serial Number of the test equipment used.

Valhalla 32-858  
 HP 4263b 2848500912

SAG

Resistance	Inner	Outer	Total	Pass	Fail
Nominal	240 mΩ to 265 mΩ	310 mΩ to 340 mΩ	550 mΩ to 605 mΩ		
Quadrant 1	Inner	x255.2 mΩ			
	Outer		x317.0 mΩ		
	Total		x572.2 mΩ		
Quadrant 2	Inner	x256.3 mΩ			
	Outer		x317.0 mΩ		
	Total		x573.5 mΩ		
Quadrant 3	Inner	x257.8 mΩ			
	Outer		x318.7 mΩ		
	Total		x576.4 mΩ		
Quadrant 4	Inner	x257.6 mΩ			
	Outer		x322.6 mΩ		
	Total		576.6 mΩ		

Inductance @ 1 Khz		Inner	Outer	Total	Pass	Fail
Nominal		575-620 $\mu$ H	1.120 to 1.17 mH	2.890 to 2.920 mH		
Quadrant 1	Inner	923.65 $\mu$ H				
	Outer		1.266 mH			
	Total			2.3347 mH		
Quadrant 2	Inner	942.180 $\mu$ H				
	Outer		1.28645 mH			
	Total			2.33801 mH		
Quadrant 3	Inner	901.725 $\mu$ H				
	Outer		1.24696 mH			
	Total			2.34670 mH		
Quadrant 4	Inner	944.030 $\mu$ H				
	Outer		1.29022 mH			
	Total			2.34668 mH		

(Q) Factor @ 1 Khz		Inner	Outer	Total	Pass	Fail
Nominal		3.3 to 3.7	4.8 to 5.3	4.5 to 5.2		
Quadrant 1	Inner	1.99				
	Outer		2.17			
	Total			5.23		
Quadrant 2	Inner	2.00				
	Outer		2.17			
	Total			5.26		
Quadrant 3	Inner	1.98				
	Outer		2.17			
	Total			5.28		
Quadrant 4	Inner	2.04				
	Outer		2.22			
	Total			5.28		

Electrical Test	Limit	Actual Measurement	Pass	Fail
Heater Strips 1/2 Resistance	9.20 to 9.60 Ω	9.215 Ω		
Heater Strips 2/3 Resistance	9.20 to 9.60 Ω	9.250 Ω		
Heater Strips 3/4 Resistance	9.20 to 9.60 Ω	9.222 Ω		
Heater Strips 4/1 Resistance	9.20 to 9.60 Ω	9.270 Ω		

A. Gould  
 Inspector

10/16/01  
 Date

X 6.2 Perform a continuity check of the IORS Voltage Taps.

Limit: No Opens

Inner	Valhalla Serial Number	Reading	Pass	Fail
Quadrant 1		2.258 Ω		
Quadrant 2		2.088 Ω		
Quadrant 3		2.057 Ω		
Quadrant 4		2.067 Ω		

A. Gould  
 Inspector

10/16/01  
 Date

~~Q1 TO GROUND mA~~  
~~Q2 TO GROUND mA~~  
~~Q3 TO GROUND mA~~  
~~Q4 TO GROUND mA~~

~~HEATER 1/2 TO GROUND~~  
~~HEATER 3/4 TO GROUND .06 mA~~  
 SNG

X 6.3 Perform a Hipot on the Collared Coil Assembly (Maximum Leakage 2.5µA)

*OK # 0261*

5 KV	Measurement(s)
Heater #1/2 to Ground	.06
Heater #2/3 to Ground	<u>DEAD SHORT - #3</u>
Heater #3/4 to Ground	.06
Heater #4/1 to Ground	.06
Heater #1/2 to Coils	.06
Heater #2/3 to Coils	.06
Heater #3/4 to Coils	.06
Heater #4/1 to Coils	.06
All 4 Quadrants to Ground	STARTED OUT @ 600V

#2 - .06

Coil to Coil 3.0 KV	Measurement(s)
Quadrant 1 to Quadrant 2	.02
Quadrant 2 to Quadrant 3	.02
Quadrant 3 to Quadrant 4	.02
Quadrant 4 to Quadrant 1	.05

*J. Howard*  
 Inspector

10/16/01  
 Date

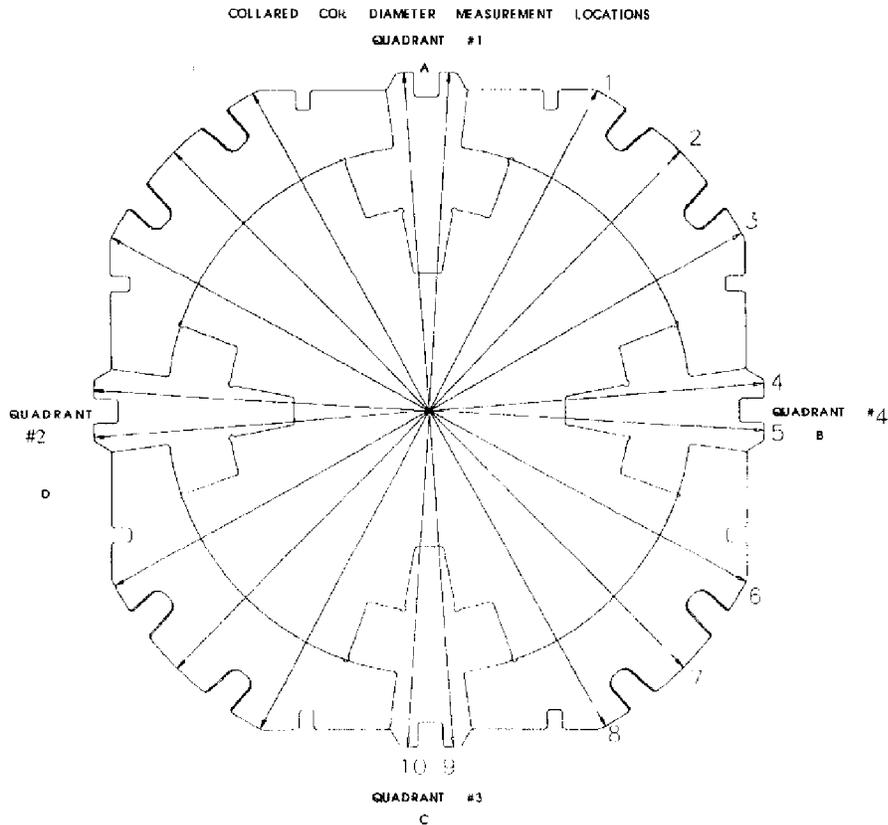


6.4 Verify that the readings in Step 6.0 are acceptable.  
 Approved for next Major Assembly Procedure.

\_\_\_\_\_  
 Responsible Authority/Physicist

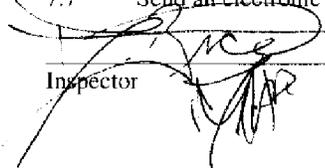
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 Date

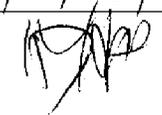
7.0 Diameter Measuring Procedure (ES-344697).



**Looking from the Lead End**

- 7.1 Using the Collared Coil Assembly Measuring Fixture, measure and record the dimension across the Collared Coil Assembly as shown at points 2, 4, 5, 7, 9 and 10.
- 7.2 Measurements are taken across the laminations.
- 7.4 Start at the Lead End of the Collared Coil Assembly.
- 7.5 Measurements along the length of the Collared Coil Assembly shall be taken at the Center of each lamination pack.
- 7.6 Insert computer printout of measurement at this page of the traveler.
- 7.7 Send an electronic copy of the computer-collected data to the Samsats II folder.

Inspector 

Date 11-9-01 

8.0 Production Complete

8.1 Process Engineering verify that the LHC Collared/Keying Traveler (5520-TR-333495) 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:

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John J. Agostata  
Process Engineering/Designee

11/7/03  
Date

870 351

# TD/ENGINEERING & FABRICATION

# PARTS KIT REQUEST

### 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: L6C

Project/Task Number: 300/1.1.1.2.5

THIS KIT LIST IS FOR: ME-369581

PART NUMBER	REV	DESCRIPTION	REQUIRED QTY/ASSY	MATERIAL		CONTROL		PROD. VERIFY PART	SUPT. VERIFY PART
				QTY ISSUED	ROUTE FORM	DATE AVAIL	DATE AVAIL		
344450	SD	TAPERED KEY	272 EA	272	75087	8/31/01			
369576		SOLID PACK	1 SKID						
MC-344150		INNER COIL ASSEMBLY	REF ONLY						
MC-344151		OUTER COIL ASSEMBLY	REF ONLY						

COLLARED COIL NUMBER: MSXbc002

RELEASED BY: J Gardner

PRODUCTION SIGNATURE: J Gardner

TODAYS DATE: 31-AUG-01

NEED DATE: 5-SEP-01

ISSUE VERIFICATION: \_\_\_\_\_

MATERIAL CONTROL SIGNATURE: Mendel Schmidt

DATE ISSUED TO STOCKROOM: 8/31/01

TRAVELER NO. TR-333495

KIT IS COMPLETE (PARTS COORDINATOR SIGNATURE): \_\_\_\_\_

STOCKROOM SIGNATURE AND DATE: Kenny Adams

DATE: 9/4/01

BADGE #: 4509

MOXBC-002

Le to Re						
Pos.#2	Pos.#4	Pos.#5	Pos.#7	Pos.#9	Pos.#10	
1	7.284	6.794	6.7955	7.283	6.7935	6.794
2	7.276	6.787	6.787	7.276	6.788	6.7895
3	7.277	6.787	6.7885	7.276	6.791	6.7905
4	7.276	6.788	6.7885	7.276	6.789	6.7895
5	7.276	6.787	6.7875	7.275	6.7895	6.789
6	7.276	6.7865	6.787	7.276	6.787	6.7895
7	7.276	6.788	6.7865	7.277	6.7895	6.7895
8	7.277	6.788	6.789	7.2775	6.7905	6.7915
9	7.2775	6.7875	6.788	7.2775	6.790	6.790
10	7.276	6.786	6.7865	7.276	6.789	6.7895
11	7.2755	6.788	6.7885	7.276	6.790	6.789
12	7.277	6.788	6.7895	7.276	6.7895	6.789
13	7.2755	6.7875	6.787	7.2765	6.791	6.791
14	7.2755	6.7885	6.7895	7.275	6.7875	6.7875
15	7.2765	6.787	6.788	7.276	6.788	6.789
16	7.276	6.788	6.7885	7.2765	6.7885	6.790
17	7.276	6.7865	6.787	7.2755	6.789	6.7895
18	7.2755	6.787	6.787	7.275	6.7885	6.7895
19	7.276	6.787	6.788	7.276	6.789	6.790
20	7.276	6.7875	6.7885	7.276	6.791	6.7905
21	7.2765	6.7875	6.7885	7.276	6.7905	6.7885
22	7.277	6.784	6.7995	7.2765	6.789	6.790
23	7.2765	6.7875	6.7885	7.276	6.789	6.7895
24	7.2755	6.788	6.788	7.276	6.790	6.790
25	7.2755	6.7875	6.7875	7.2755	6.7885	6.7895
26	7.276	6.788	6.7885	7.2765	6.7905	6.7905
27	7.276	6.7885	6.788	7.276	6.7875	6.7895
28	7.276	6.7865	6.7865	7.2765	6.787	6.7885
29	7.2765	6.7875	6.7875	7.276	6.7895	6.789
30	7.2765	6.7875	6.788	7.276	6.789	6.7895
31	7.277	6.789	6.7885	7.276	6.787	6.7875
32	7.276	6.7885	6.788	7.276	6.7875	6.789
33	7.2765	6.7865	6.7885	7.276	6.7895	6.789
34	7.276	6.786	6.7865	7.276	6.7915	6.792
35	7.2735	6.7855	6.786	7.274	6.790	6.786
36	7.2805	6.7845	6.789	7.281	6.793	6.7925

HAND MEASURES!

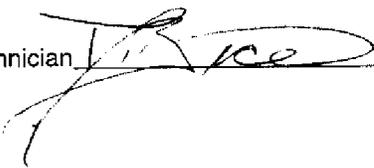
S. Gould

W. SCHEWE

10/17/01

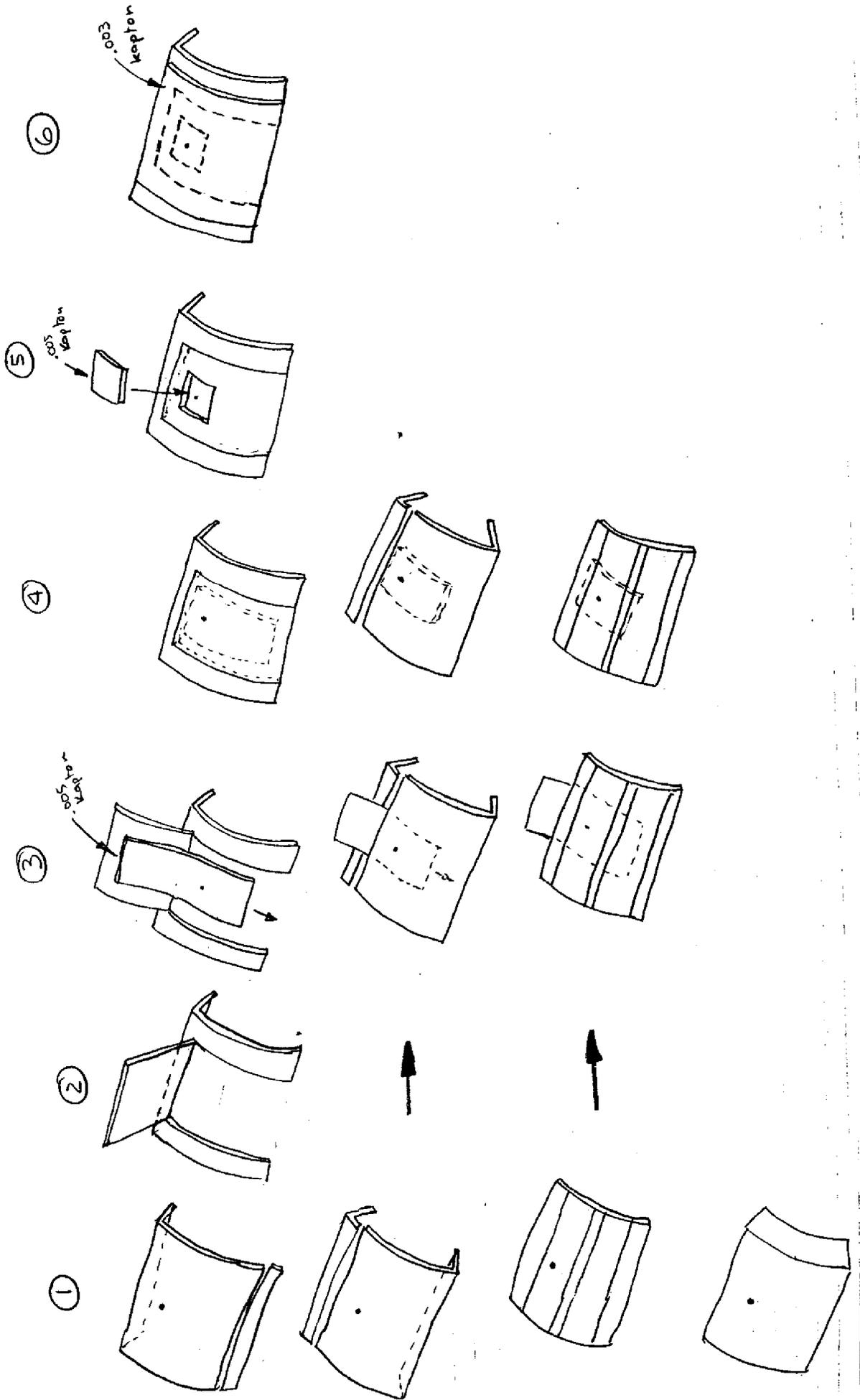
## MQXBC-02 (After rekeying)

Le to Re	Le to Re	Le to Re	Le to Re	Le to Re	Le to Re
Pos#2	Pos#4	Pos#5	Pos#7	Pos#9	Pos#10
0" 7.286	6.749	6.801	7.285	6.795	6.796
6" 7.278	6.790	6.791	7.278	6.790	6.790
12" 7.279	6.789	6.790	7.277	6.791	6.791
18" 7.277	6.791	6.791	7.277	6.792	6.790
24" 7.2765	6.789	6.791	7.276	6.790	6.790
30" 7.276	6.796	6.789	7.276	6.788	6.789
36" 7.276	6.790	6.789	7.279	6.790	6.790
42" 7.279	6.790	6.790	7.277	6.790	6.791
48" 7.277	6.788	6.789	7.276	6.790	6.791
54" 7.278	6.788	6.788	7.276	6.790	6.790
60" 7.277	6.789	6.790	7.276	6.789	6.789
66" 7.277	6.789	6.791	7.276	6.789	6.790
72" 7.276	6.789	6.792	7.276	6.790	6.789
78" 7.276	6.790	6.789	7.276	6.788	6.788

Technician 

Date 11-9-01

1MQXB02 Ground Wrap Repair  
DR # 0261



Revision Request Control Number: 1516

Specification Number: 5520 - TR - 333495 Current Revision: G

Traveler or Document Title LHC Collaring and Keying Traveler

Step #/Description of Revision:

- 3.9 Added Step. "Connect the Valhalla to the Coils during Collaring to monitor resistance." per MQXBC-007.
- 4.0 Modified Note. Changed "collaring" to "keying".
- 4.3 Modified Step. Added "If keys fail to remain seated, inform Crew Chief and record actual pump pressure recommended by Crew Chief and obtain signature below."
- 4.5 Modified Step. Changed "drop" to "raise" in sub-step 2).
- 4.6 Modified Step. Changed "drop" to "raise" in sub-step 2).
- 4.8 Modified Step. Changed "drop" to "raise" in sub-steps 1) and 2).
- 4.9 Modified Step. "If keys are not fully inserted, increase Main and/or Key pusher pressure and record below."
- 6.1 Modified Step. Changed "Full Scale Voltage" setting from 20 mV to 2V per MQXBC-002.

John Szostak

Originator

Jim Rife

Responsible Authority

11/14/2002

Date

Revision Incorporated into the Traveler:

John Szostak

Revision Incorporated By

2/27/2003

Date

Process Engineering Final Review:

Jamie Blowers

Process Engineering/Designee

2/27/2003

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.

Traveler Title:

LHC Collaring and Keying Traveler

Specification No:

5520-TR-333495

Revision:

B

DR No:

HGQ-0261

Step No:

6.3

Drawing No:

Routing Form No:

Serial No:

MQXBC-002

Discrepancy Description:

Heater #2/3 (Heater strip on Quadrant #3) has a dead short to ground and also shorts to coil at a low voltage. Coil to ground also shorted out at a low voltage.

Originator:

Steve Gould

Date:

10/16/2001

Cause of Nonconformance:

Weld slag between ground wrap and collar. (Entered into Database on 7/23/02 - John Szostak)

Responsible Authority:

Rodger Bossert

Date:

10/16/2001

**Disposition:**

Un-collar area with short, patch as shown in attached sketch, re-key section and proceed. (Entered into Database on 7/23/02 - John Szostak)

**Responsible Authority:**

Rodger Bossert

**Date:**

10/16/2001

**Corrective Action to Prevent Recurrence:**

Traveler needs more extensive inspection of collar packs before collaring. Include thorough cleaning on production floor. (TRR No. 1258) (Entered into Database on 7/23/02 - John Szostak)

**Responsible Authority:**

Rodger Bossert

**Date:**

10/16/2001

**Corrective Action/Disposition Verified By:**

Rodger Bossert

**Date:**

10/16/2001

Will Configuration be affected?:  YES  NO

**Identified problem area:**

- Material       Manpower       Method       Machine       Measurement

**Reviewed By:**

Bob Jensen

**Date:**

11/20/2001

Revision Request Control Number: 1258

Specification Number: 5520 - TR - 333495 Current Revision: B

Traveler or Document Title LHC Collaring and Keying Traveler

Step #/Description of Revision:

- 3.1 Added Step. Inspect Coil for any Weld Slag. DR No. HGQ-0259.
- 3.2 Modified Step. Added Drawing Number.
- 3.3 Modified Step. Added more detail to step for upending.
- 3.4 Added Step. "Install Non-Lead End Hardware."
- 3.5 Modified Step. Specified Drawing Number.
- 3.6 Modified Step. Changed Drawing name and Number.
- 4.3 Modified Step. Included Detailed Keying Procedures. DR No. HGQ-0260.
- 4.4 Modified Step. Included Detailed Keying Procedures. DR No. HGQ-0260.
- 4.5 Added Step. Included Detailed Keying Procedures. DR No. HGQ-0260.
- 4.6 Added Step. Included Detailed Keying Procedures. DR No. HGQ-0260.
- 4.7 Added Step. Included Detailed Keying Procedures. DR No. HGQ-0260.
- 4.8 Added Step. Included Detailed Keying Procedures. DR No. HGQ-0260.
- 6.3 Modified Step. Changed HiPot Table. Heaters grounded for Coil to Ground check. Coil grounded for Heaters to Ground check. Added Pictures.

Jim Rife

Originator

Jamie Blowers

Responsible Authority

11/29/2001

Date

Revision Incorporated into the Traveler:

John Szostak

Revision Incorporated By

11/29/2001

Date

Process Engineering Final Review:

Bob Jensen

Process Engineering/Designee

11/29/2001

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.

<b>Traveler Title:</b>	<b>Specification No:</b>	<b>Revision:</b>	<b>DR No:</b>
LHC Collaring and Keying Traveler	5520-TR-333495	B	HGQ-0256

<b>Step No:</b>	<b>Drawing No:</b>	<b>Routing Form No:</b>	<b>Serial No:</b>	<b>Rework ID:</b>
4.2	ME-369581		MQXBC-002	

**Discrepancy Description:**

During collaring massaging the assembly developed a Q2 coil to heater to tooling short. Short is to tooling only and not body collars.

**Originator:**  
Jim Rife

**Date:**  
9/26/2001

**Cause of Nonconformance:**

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

**Responsible Authority:**  
Rodger Bossert

**Date:**  
9/26/2001

**Disposition:**

(Re-issue 333495 Steps 3.1 to 4.5 - 9/26/01 - John Szostak)

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,

**Responsible Authority:**

Rodger Bossert

**Date:**

9/26/2001

**Corrective Action to Prevent Recurrence:**

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

**Responsible Authority:**

Rodger Bossert

**Date:**

9/26/2001

**Corrective Action/Disposition Verified By:**

Rodger Bossert

**Date:**

10/5/2001

Will Configuration be affected?:  YES  NO

**Identified problem area:**

Material  Manpower  Method  Machine  Measurement

**Reviewed By:**

Bob Jensen

**Date:**

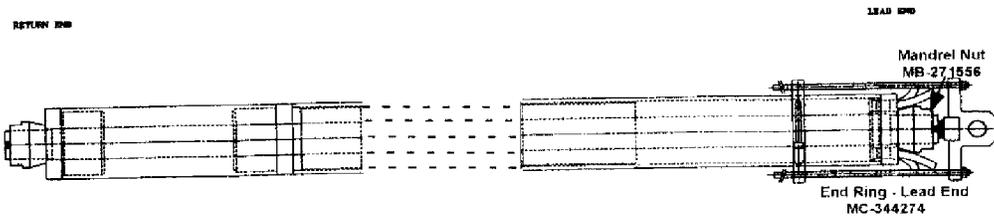
10/8/2001

3.0 Collaring

3.1 Clean all Mandrel hardware with Isopropyl Alcohol (Fermi stock 1920-0300) and Heavy Disposable Wipes (Fermi stock 1660-2600) or equivalent.

*[Signature]*  
Technician(s) 10-4-01  
Date

3.2 Install the Nuts and the Lifting Eye onto the Lead End of the Mandrel.



*[Signature]*  
Technician(s) 10-4-01  
Date

3.3 Lift vertically with the crane and transport the Collared Coil Assembly to the Keying Press and insert the Collared Coil Assembly into the Keying Press.

*[Signature]*  
Technician(s) 10/4/01  
Date

3.4 Machine the End Collar Lamination Packs (8) in accordance with the End Pack Modification Drawings (MX-XXXXXX).

*[Signature]*  
Technician(s) 10/8/01  
Date

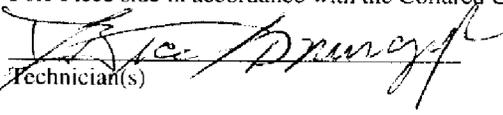
3.5 Install the Return End Collar Lamination Packs with 5 mil self adhesive kapton on the Pole Piece side in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

Note(s):  
Remove shrink-wrap Mylar in 3" sections to prevent the ground wrap from loosening during collaring.  
*[Signature]*  
Technician(s) 10/8/01  
Date

3.6 Install the Collar Lamination Packs in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

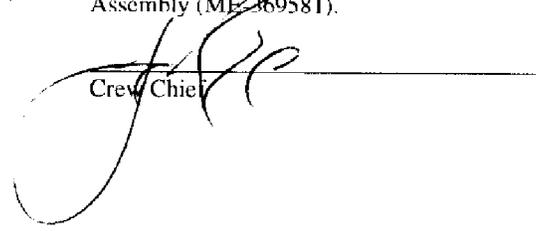
Note(s):  
Remove shrink-wrap Mylar in 3" sections to prevent the ground wrap from loosening during collaring.  
*[Signature]*  
Technician(s) 10-8-01  
Date

- 3.7 Install the Modified Lead End Collar Lamination Packs with 5 mil self adhesive kapton on the Pole Piece side in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

  
\_\_\_\_\_  
Technician(s)

10-8-01  
\_\_\_\_\_  
Date

- 3.8 Verify the Lamination Packs are tight and in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

  
\_\_\_\_\_  
Crew Chief

10-8-01  
\_\_\_\_\_  
Date



<b>Traveler Title:</b>	<b>Specification No:</b>	<b>Revision:</b>	<b>DR No:</b>
LHC Collaring and Keying Traveler	5520-TR-333495	B	HGQ-0260

<b>Step No:</b>	<b>Drawing No:</b>	<b>Routing Form No:</b>	<b>Serial No:</b>	<b>Rework ID:</b>
4.4	ME369581		MQXBC-002-1	1

**Discrepancy Description:**

Deviated from collar keying procedure in traveler per following:

1. Partial insert keys from LE to RE, 3000 pump psi main cylinders, 700 pump psi key pushers, first set of keys stick above collar pack ~1/2".
2. Second pass press keys from LE to RE, 4400 pump psi main cylinders, 2700 pump psi key pushers, 6" increments, not staggered over key splits.
3. Third pass press keys from LE to RE. 4700 pump psi main cylinders, 3300 pump psi key pushers, 6" increments, not staggered over key splits.
4. Fourth pass press keys from LE to RE, 5000 pump psi main cylinders, 3600 pump psi key pushers, 3" increments.
5. Fifth pass press keys from RE to LE, 5000 pump psi main cylinders, 4000 pump psi key pushers, 3" increments.
6. Sixth pass press keys from LE to RE, 5000 pump psi main cylinders, 4000 pump psi key pushers, 6" increments, stagger to press on key splits.

**Originator:**

**Date:**

**Cause of Nonconformance:**

This magnet required more passes to close than the procedure indicates. (Entered into Database on 7/24/02 - John Szostak)

**Responsible Authority:**

**Date:**

**Disposition:**

Proceed with the magnet. (Entered into Database on 7/24/02 - John Szostak)

**Responsible Authority:**

Rodger Bossert

**Date:**

10/11/2001

**Corrective Action to Prevent Recurrence:**

All long magnets have required more extensive, "ad-hoc" keying procedures than specified to fully insert them. We should reconsider the keying procedure and modify it based on past experience if necessary. (Entered into Database on 7/24/02 - John Szostak)

**Responsible Authority:**

Rodger Bossert

**Date:**

11/10/2001

**Corrective Action/Disposition Verified By:**

Rodger Bossert

**Date:**

11/10/2001

Will Configuration be affected?:  YES  NO

**Identified problem area:**

- Material       Manpower       Method       Machine       Measurement

**Reviewed By:**

Bob Jensen

**Date:**

11/20/2001

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

<b>Step No:</b>	<b>Drawing No:</b>	<b>Routing Form No:</b>	<b>Serial No:</b>	<b>Rework ID:</b>
4.3	ME-369581		MQXBC-002-1	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 & 333495 travelers 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:**

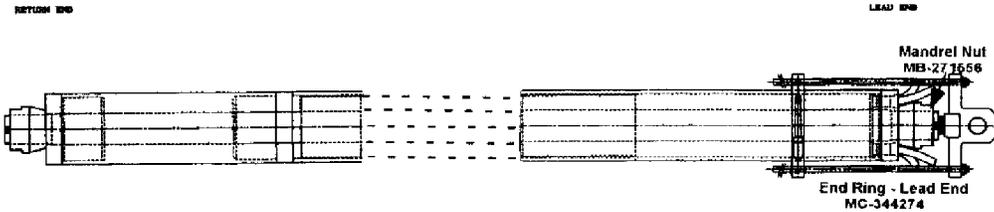
11/20/2001

3.0 Collaring

3.1 Clean all Mandrel hardware with Isopropyl Alcohol (Fermi stock 1920-0300) and Heavy Disposable Wipes (Fermi stock 1660-2600) or equivalent.

N/A  
Technician(s) \_\_\_\_\_ Date \_\_\_\_\_

3.2 Install the Nuts and the Lifting Eye onto the Lead End of the Mandrel.



NA  
Technician(s) \_\_\_\_\_ Date \_\_\_\_\_

3.3 Lift vertically with the crane and transport the Collared Coil Assembly to the Keying Press and insert the Collared Coil Assembly into the Keying Press.

NA  
Technician(s) \_\_\_\_\_ Date \_\_\_\_\_

3.4 Machine the End Collar Lamination Packs (8) in accordance with the End Pack Modification Drawings (MX-XXXXXX).

NA  
Technician(s) \_\_\_\_\_ Date \_\_\_\_\_

3.5 Install the Return End Collar Lamination Packs with 5 mil self adhesive kapton on the Pole Piece side in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

Note(s):

Remove shrink-wrap Mylar in 3" sections to prevent the ground wrap from loosening during collaring.

N/A  
Technician(s) \_\_\_\_\_ Date \_\_\_\_\_

3.6 Install the Collar Lamination Packs in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

Note(s):

Remove shrink-wrap Mylar in 3" sections to prevent the ground wrap from loosening during collaring.

N/A  
Technician(s) \_\_\_\_\_ Date \_\_\_\_\_

1. PARTIAL INSERTED w/ 4000 INCH # 2700 PSI KEY PRESS  
2.

- 3.7 Install the Modified Lead End Collar Lamination Packs with 5 mil self adhesive kapton on the Pole Piece side in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

N/A  
\_\_\_\_\_  
Technician(s)

\_\_\_\_\_  
Date

- 3.8 Verify the Lamination Packs are tight and in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

[Signature]  
\_\_\_\_\_  
Crew Chief

11/8-01  
\_\_\_\_\_  
Date

4.0 Keying Procedure

Note(s):

Operate the Press in accordance with the Operating Procedure (OP-333503)  
Monitor resistance of the magnet during the entire Collaring Procedure.  
Resistance change of no more than 3 mOhms is allowed.

4.1 Massage the Collared Coil Assembly at 900-pump psi. from Lead End to Return End.

N/A  
\_\_\_\_\_  
Technician(s) Date

4.2 Massage the Collared Coil Assembly at 1800 pump psi from Return End to Lead End.

N/A  
\_\_\_\_\_  
Technician(s) Date

4.3 Partially insert Keys from the Lead End to Return End. Use 3000 pump psi main pusher pressure and 700-pump psi Key pusher pressure for this step.

Note(s):

As needed modify the length of the keys 6" above the End of the Assembly to Ensure the final key is > 4" in length.  
Verify the Mandrel Nut is hand tight every 4 ft (four times) of Keying.  
Engage the Main Pushers, and then the Key Pushers, release the Main Pushers, and then the Key Pushers.

NA  
\_\_\_\_\_  
Technician(s) Date

4.4 Fully insert Keys from the Lead End to Return End. Use 4400 pump psi main pusher pressure and 2700-pump psi Key pusher pressure.

Note(s):

Verify the Mandrel Nut is hand tight every 4 ft (four times) of Keying.  
Engage the Main Pushers, and then the Key Pushers, release the Main Pushers, and then the Key Pushers.

NA  
\_\_\_\_\_  
Technician(s) Date

X 4.5 While Lowering and Raising the Coil Assembly, visually inspect Keys to verify they are fully inserted.

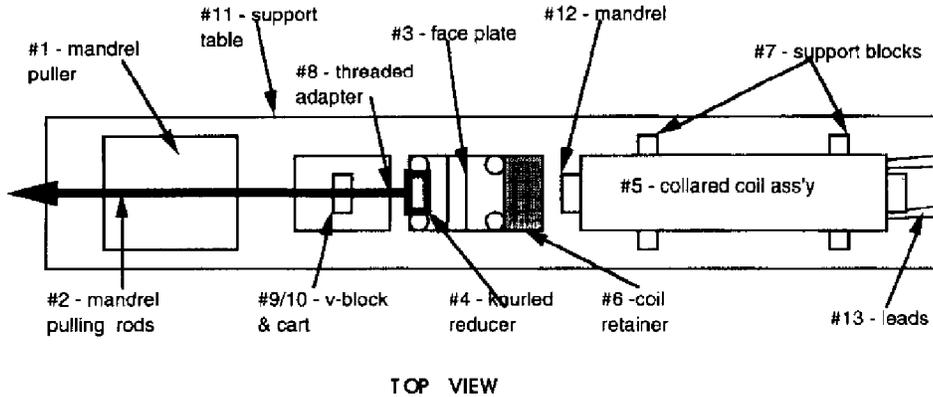
[Signature]  
\_\_\_\_\_  
Inspector Date

4.6 Bring the Collared Coil Assembly horizontal using Approved and Appropriate procedures

NA  
\_\_\_\_\_  
Technician(s) Date

- 1. PARTIAL INSERT KEY @ 4400 PUMP PSI MAIN & 2000 P. PSI KEYS
- 2. SECOND PASS @ 1800 P. PSI MAIN & 500 P. PSI KEYS. STANDARD SPEC.
- 3. THIRD PASS @ 4400 P. PSI MAIN & 500 P. PSI KEYS. STANDARD SPEC.

5.0 Pulling the Mandrel



**Note(s):**  
**Mandrel should be pulled out from return end of Collared Coil Assembly. Ensure that the Mandrel is kept in the correct radial position with respect to coils during extraction by inserting Mandrel into holding tooling (MC-344284) and Collar Laminations into Cradles (MD-344281)**

- 5.1 The Mandrel pulling rods (2) are to be picked up by the crane and pushed into the Mandrel Puller (1) until they click into the groove. The rods should be about 6" from the face plate (3). To displace the weight of the rods, a cart (9) with a V block (10) shall be used to support the pulling rods.
- 5.2 The Collared Coil Assembly (5) shall then be picked up with the crane using two slings so it remains level. It is then placed on the support blocks (7) so the coil retainer (6) is flush against the face plate (3).
- 5.3 The knurled reducer (4) is then screwed into the Mandrel (12) so the threaded adapter (8) can be screwed from the rods (2) to the reducer (4).
- 5.4 The Mandrel Puller (1) shall be warmed up about 20-30 minutes before pulling the Mandrel (12). The crane shall also be left on the slings with the Collared Coil Assembly during the pulling process.
- 5.5 Leads (13) shall be secured (cable tied) so they are out of the way during the process.

N/A  
 Technician(s)

\_\_\_\_\_  
 Date

6.0 Final Inspection

- X 6.1 Perform an electrical inspection on each of the individual Inner and Outer Coils, Quadrants and Heaters. Refer to the Valhalla and Leader Free Standing Coil Measurement Procedure (ES-292306).

**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 the disconnect status safe light is lit while connecting and disconnecting test leads from the Coil Assembly.**

**Valhalla 4300B settings:**

**Power must be on for 30 minutes before testing.**

Test Current	_____	Off
Power	_____	On
Full Scale Voltage	_____	20mv
Amp Selector Knob	_____	1 A
Temperature Compensator	_____	On
Test Current	_____	On (testing)

**Hp 4263B:**

Function	_____	"Ls-Q" selected
Freq	_____	1 Khz

Record the Serial Number of the test equipment used.

Valhalla	<u>32-858</u>
HP 4263b	<u>28418J00912</u>

Resistance		Inner	Outer	Total	Pass	Fail
Nominal		240 mΩ to 265 mΩ	310 mΩ to 340 mΩ	550 mΩ to 605 mΩ		
Quadrant 1	Inner	.2560 mΩ				
	Outer		.3180 mΩ			
	Total			.5739 mΩ		
Quadrant 2	Inner	.2570 mΩ				
	Outer		.3178 mΩ			
	Total			.5747 mΩ		
Quadrant 3	Inner	.2567 mΩ				
	Outer		.3166 mΩ			
	Total			.5748 mΩ		
Quadrant 4	Inner	.2566 mΩ				
	Outer		.3177 mΩ			
	Total			.5741 mΩ		

Inductance @ 1 KHz		Inner	Outer	Total	Pass	Fail
Nominal		575-620 $\mu$ H	1.120 to 1.17 mH	2.890 to 2.920 mH		
Quadrant 1	Inner	878.136 $\mu$ H				
	Outer		1.22037 mH			
	Total			2.33270 mH		
Quadrant 2	Inner	849.850 $\mu$ H				
	Outer		1.19279 mH			
	Total			2.33942 mH		
Quadrant 3	Inner	833.111 $\mu$ H				
	Outer		1.17589 mH			
	Total			2.33920 mH		
Quadrant 4	Inner	804.841 $\mu$ H				
	Outer		1.24843 mH			
	Total			2.34274 mH		

(Q) Factor @ 1 KHz		Inner	Outer	Total	Pass	Fail
Nominal		3.3 to 3.7	4.8 to 5.3	4.5 to 5.2		
Quadrant 1	Inner	2.11				
	Outer		2.30			
	Total			5.35		
Quadrant 2	Inner	2.07				
	Outer		2.27			
	Total			5.35		
Quadrant 3	Inner	2.05				
	Outer		2.25			
	Total			5.40		
Quadrant 4	Inner	2.19				
	Outer		2.37			
	Total			5.39		

Electrical Test	Limit	Actual Measurement	Pass	Fail
Heater Strips 1/2 Resistance	9.20 to 9.60 Ω	9.222 Ω		
Heater Strips 2/3 Resistance	9.20 to 9.60 Ω	9.210 Ω		
Heater Strips 3/4 Resistance	9.20 to 9.60 Ω	9.260 Ω		
Heater Strips 4/1 Resistance	9.20 to 9.60 Ω	9.198 Ω		

Inspector [Signature]

Date 11-3-01

- X 6.2 Perform a continuity check of the IORS Voltage Taps.

Limit: No Opens

Inner	Valhalla Serial Number	Reading	Pass	Fail
Quadrant 1				
Quadrant 2				
Quadrant 3				
Quadrant 4				

Inspector [Signature]

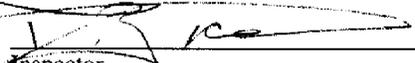
Date \_\_\_\_\_

X 6.3 Perform a Hipot on the Collared Coil Assembly (Maximum Leakage 2.5µA)

5 KV	Measurement(s)
Heater #1/2 to Ground	.08
Heater #2/3 to Ground	.08
Heater #3/4 to Ground	.08
Heater #4/1 to Ground	.08
Heater #1/2 to Coils	.08
Heater #2/3 to Coils	.08
Heater #3/4 to Coils	.08
Heater #4/1 to Coils	.08
All 4 Quadrants to Ground	.02

Coil to Coil 3.0 KV	Measurement(s)
Quadrant 1 to Quadrant 2	.01
Quadrant 2 to Quadrant 3	.01
Quadrant 3 to Quadrant 4	.01
Quadrant 4 to Quadrant 1	.01

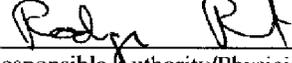
Def 0269

  
 Inspector

11-8-01  
Date

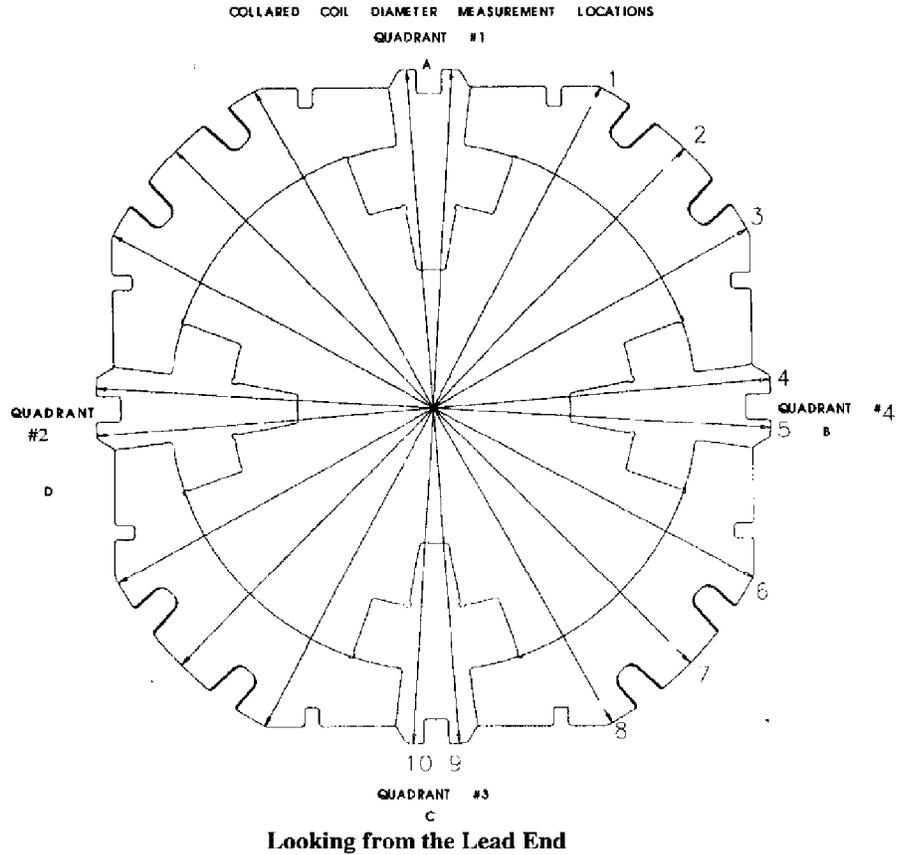


6.4 Verify that the readings in Step 6.0 are acceptable. Approved for next Major Assembly Procedure.

  
 Responsible Authority/Physicist

11/8/01  
Date

7.0 Diameter Measuring Procedure (ES-344697).



- 7.1 Using the Collared Coil Assembly Measuring Fixture, measure and record the dimension across the Collared Coil Assembly as shown at points 2, 4, 5, 7, 9 and 10.
- 7.2 Measurements are taken across the laminations.
- 7.4 Start at the Lead End of the Collared Coil Assembly.
- 7.5 Measurements along the length of the Collared Coil Assembly shall be taken at the Center of each lamination pack.
- 7.6 Insert computer printout of measurement at this page of the traveler.
- 7.7 Send an electronic copy of the computer-collected data to the Samsats II folder.

Inspector *[Signature]*

Date 11-9-01

8.0 Production Complete

- 8.1 Process Engineering verify that the LHC Collared/Keying Traveler (5520-TR-333495) 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:

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*John J. Sycostak*  
 Process Engineering/Designee

11/7/03  
 Date

<b>Traveler Title:</b> LHC Collaring and Keying Traveler	<b>Specification No:</b> 5520-TR-333495	<b>Revision:</b> B	<b>DR No:</b> HGQ-0269
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<b>Step No:</b> 6.3	<b>Drawing No:</b> ME-369581 Rev. None	<b>Routing Form No:</b> 	<b>Serial No:</b> MQXBC-002-2	<b>Rework ID:</b> 
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**Discrepancy Description:**

Coil to Coil short in Q3 - Q4 at Return End.

**Originator:**  
Damon Bice

**Date:**  
11/8/2001

**Cause of Nonconformance:**

Both outer coils were scraped near the spot where the saddle feathers to zero thickness. (Entered into Database on 9/25/02 - John Szostak)

**Responsible Authority:**  
Rodger Bossert

**Date:**  
11/8/2001

**Disposition:**

Add .003 kapton to each parting plane to cover area and varnish scrape. Continue with assembly. (Entered into Database on 9/25/02 - John Szostak)

**Responsible Authority:**

Rodger Bossert

**Date:**

11/8/2001

**Corrective Action to Prevent Recurrence:**

Inspect these areas of all Outer Coils before assembling to ensure no scrapes exist. (Entered into Database on 9/25/02 - John Szostak)

**Responsible Authority:**

Rodger Bossert

**Date:**

11/8/2001

**Corrective Action/Disposition Verified By:**

Rodger Bossert

**Date:**

11/8/2001

Will Configuration be affected?:  YES  NO

**Identified problem area:**

Material  Manpower  Method  Machine  Measurement

**Reviewed By:**

Bob Jensen

**Date:**

1/11/2002

Traveler Title:

LHC End Can Installation Traveler

Specification No:

5520-TR-333496

Revision:

A

DR No:

HGQ-0282

Step No:

8.5

Drawing No:

ME-369580

Routing Form No:

Serial No:

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



**Fermi National Accelerator Laboratory  
Batavia, IL 60510**

**LARGE HADRON COLLIDER  
COLLARING & KEYING TRAVELER**

**Reference Drawing(s)  
Collared Coil Assembly  
ME-369581**

Project/Task Number: **300/1.1.1.6.2**

Budget Code: <b>LPT</b>		Project Code: <b>the CMAS</b>
Released by: <i>J. Hostak</i>		Date: <b>11/21/01</b>
Prepared by: <b>M. Cullen, J. Larson</b>		Magnet/Device Series: <b>LQXB</b>
Title	Signature	Date
TD / E&F Process Engineering	<i>Bob Jensen</i> Bob Jensen/Designer	<b>9/11/01</b>
TD / LHC Production Supervisor	<i>[Signature]</i> [Signature]/Designer	<b>9-11-01</b>
TD /LHC Production Engineer	<i>[Signature]</i> Rodger Bossett/Designer	<b>9-11-01</b>
TD / LHC Tooling Engineer	<i>[Signature]</i> John Carson/Designer	<b>9/11/01</b>
TD / LHC Program Manager	<i>[Signature]</i> Jim Kelly/Designer	<b>9/11/01</b>

Revision Page

<u>Revision</u>	<u>Step No.</u>	<u>Revision Description</u>	<u>TRR No.</u>	<u>Date</u>
None	N/A	Initial Release	N/A	10/16/00
A	3.0	Modified the Lamination Packs and added Kapton.	1183	6/13/01
	4.0	Removed Strain Gauges		
	5.0	Added Electrical Limits		
B	5.0	Removed electrical limits, added engineer sign off.	1192	9/11/01
	5.0	Broke into three steps (5.0, 6.0, 7.0)		

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 as applicable.
- 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 List for the LHC Collared Coil Keying Traveler 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.

NA  
 Process Engineering/Designee

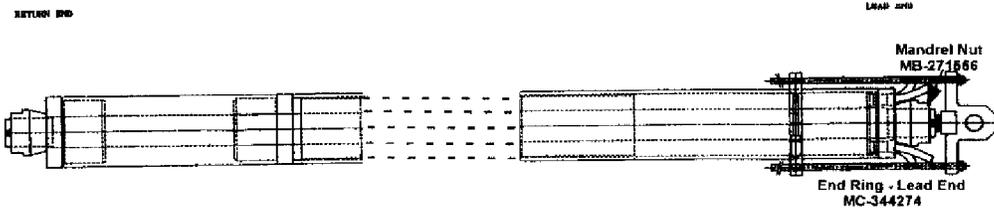
11/21/01  
 Date

3.0 Collaring

- 3.1 Clean all Mandrel hardware with Isopropyl Alcohol (Fermi stock 1920-0300) and Heavy Disposable Wipes (Fermi stock 1660-2600) or equivalent.

[Signature] Technician(s) 11-21-01 Date

- 3.2 Install the Nuts and the Lifting Eye onto the Lead End of the Mandrel.



[Signature] Technician(s) 11-21-01 Date

- 3.3 Lift vertically with the crane and transport the Collared Coil Assembly to the Keying Press and insert the Collared Coil Assembly into the Keying Press.

[Signature] Technician(s) 11-21-01 Date

- 3.4 Machine the End Collar Lamination Packs (8) in accordance with the End Pack Modification Drawings (MX-XXXXXX).

[Signature] Technician(s) 11-21-01 Date

- 3.5 Install the Return End Collar Lamination Packs with 5 mil self adhesive kapton on the Pole Piece side in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

Note(s):

Remove shrink-wrap Mylar in 3" sections to prevent the ground wrap from loosening during collaring.

[Signature] Technician(s) 11-21-01 Date

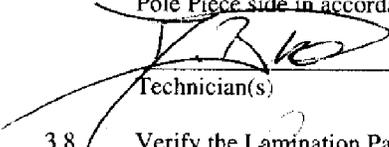
- 3.6 Install the Collar Lamination Packs in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

Note(s):

Remove shrink-wrap Mylar in 3" sections to prevent the ground wrap from loosening during collaring.

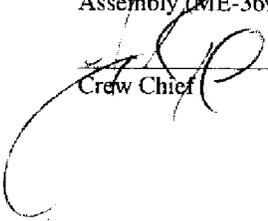
[Signature] Technician(s) 11-21-01 Date

3.7 Install the Modified Lead End Collar Lamination Packs with 5 mil self adhesive kapton on the Pole Piece side in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

  
\_\_\_\_\_  
Technician(s)

11-21-01  
Date

3.8 Verify the Lamination Packs are tight and in accordance with the Collared Coil W/O Ends Assembly (ME-369581).

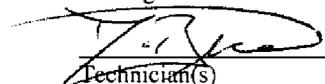
  
\_\_\_\_\_  
Crew Chief

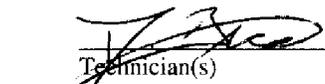
11-21-01  
Date

4.0 Keying Procedure

**Note(s):**

**Operate the Press in accordance with the Operating Procedure (OP-333503)  
Monitor resistance of the magnet during the entire Collaring Procedure.  
Resistance change of no more than 3 mOhms is allowed.**

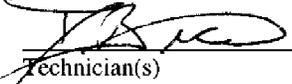
4.1 Massage the Collared Coil Assembly at 900-pump psi. from Lead End to Return End.  
 \_\_\_\_\_ 11-21-01  
Technician(s) Date

4.2 Massage the Collared Coil Assembly at 1800 pump psi from Return End to Lead End.  
 \_\_\_\_\_ 11-21-01  
Technician(s) Date

4.3 Partially insert Keys from the Lead End to Return End. Use 3000 pump psi main pusher pressure and 700-pump psi Key pusher pressure for this step.

**Note(s):**

**As needed modify the length of the keys 6" above the End of the Assembly to  
Ensure the final key is > 4" in length.  
Verify the Mandrel Nut is hand tight every 4 ft (four times) of Keying.  
Engage the Main Pushers, and then the Key Pushers, release the Main Pushers,  
and then the Key Pushers.**

 \_\_\_\_\_ 11-21-01  
Technician(s) Date

4.4 Fully insert Keys from the Lead End to Return End. Use 4400 pump psi main pusher pressure and 2700-pump psi Key pusher pressure.

**Note(s):**

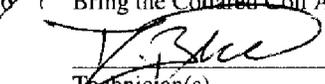
**Verify the Mandrel Nut is hand tight every 4 ft (four times) of Keying.  
Engage the Main Pushers, and then the Key Pushers, release the Main Pushers,  
and then the Key Pushers.**

 \_\_\_\_\_ 11-21-01  
Technician(s) Date

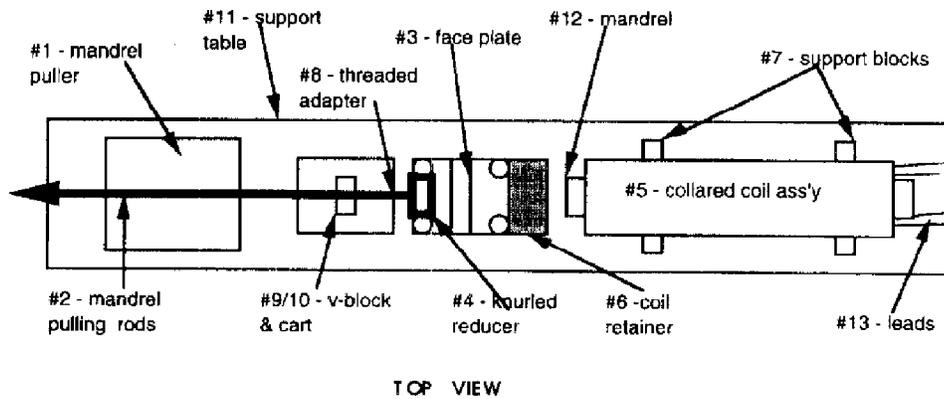
X 4.5 While Lowering and Raising the Coil Assembly, visually inspect Keys to verify they are fully inserted.

 \_\_\_\_\_ 11-21-01  
Inspector Date

4.6 Bring the Collared Coil Assembly horizontal using Approved and Appropriate procedures

 \_\_\_\_\_ 11-21-01  
Technician(s) Date

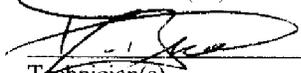
5.0 Pulling the Mandrel



Note(s):

**Mandrel should be pulled out from return end of Collared Coil Assembly. Ensure that the Mandrel is kept in the correct radial position with respect to coils during extraction by inserting Mandrel into holding tooling (MC-344284) and Collar Laminations into Cradles (MD-344281)**

- 5.1 The Mandrel pulling rods (2) are to be picked up by the crane and pushed into the Mandrel Puller (1) until they click into the groove. The rods should be about 6" from the face plate (3). To displace the weight of the rods, a cart (9) with a V block (10) shall be used to support the pulling rods.
- 5.2 The Collared Coil Assembly (5) shall then be picked up with the crane using two slings so it remains level. It is then placed on the support blocks (7) so the coil retainer (6) is flush against the face plate (3).
- 5.3 The knurled reducer (4) is then screwed into the Mandrel (12) so the threaded adapter (8) can be screwed from the rods (2) to the reducer (4).
- 5.4 The Mandrel Puller (1) shall be warmed up about 20-30 minutes before pulling the Mandrel (12). The crane shall also be left on the slings with the Collared Coil Assembly during the pulling process.
- 5.5 Leads (13) shall be secured (cable tied) so they are out of the way during the process.

  
 \_\_\_\_\_  
 Technician(s)

11-21-01  
 \_\_\_\_\_  
 Date

6.0 Final Inspection

- X 6.1 Perform an electrical inspection on each of the individual Inner and Outer Coils, Quadrants and Heaters. Refer to the Valhalla and Leader Free Standing Coil Measurement Procedure (ES-292306).

**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 the disconnect status safe light is lit while connecting and disconnecting test leads from the Coil Assembly.**

**Valhalla 4300B settings:**

**Power must be on for 30 minutes before testing.**

Test Current \_\_\_\_\_ Off  
 Power \_\_\_\_\_ On  
 Full Scale Voltage \_\_\_\_\_ 20mv  
 Amp Selector Knob \_\_\_\_\_ 1 A  
 Temperature Compensator \_\_\_\_\_ On  
 Test Current \_\_\_\_\_ On (testing)

**Hp 4263B:**

Function \_\_\_\_\_ "Ls-Q" selected  
 Freq \_\_\_\_\_ 1 Khz

Record the Serial Number of the test equipment used.

Valhalla \_\_\_\_\_

HP 4263b \_\_\_\_\_

Resistance		Inner	Outer	Total	Pass	Fail
Nominal		240 mΩ to 265 mΩ	310 mΩ to 340 mΩ	550 mΩ to 605 mΩ		
Quadrant 1	Inner	.2558 mΩ				
	Outer		.3180 mΩ			
	Total			.5738 mΩ		
Quadrant 2	Inner	.2567 mΩ				
	Outer		.3178 mΩ			
	Total			.5745 mΩ		
Quadrant 3	Inner	.2569 mΩ				
	Outer		.3178 mΩ			
	Total			.5738 mΩ		
Quadrant 4	Inner	.2570 mΩ				
	Outer		.3185 mΩ			
	Total			.5752 mΩ		

Inductance @ 1 Khz		Inner	Outer	Total	Pass	Fail
Nominal		575-620 $\mu$ H	1.120 to 1.17 mH	2.890 to 2.920 mH		
Quadrant 1	Inner	895.198 $\mu$ H				
	Outer		1.17488 mH			
	Total			2.33853 mH		
Quadrant 2	Inner	892.847 $\mu$ H				
	Outer		1.24914 mH			
	Total			2.34091 mH		
Quadrant 3	Inner	808.917 $\mu$ H				
	Outer		1.09897 mH			
	Total			2.3475 mH		
Quadrant 4	Inner	867.804 $\mu$ H				
	Outer		1.2545 mH			
	Total			2.34799 mH		

(Q) Factor @ 1 Khz		Inner	Outer	Total	Pass	Fail
Nominal		3.3 to 3.7	4.8 to 5.3	4.5 to 5.2		
Quadrant 1	Inner	2.13				
	Outer		2.23			
	Total			5.35		
Quadrant 2	Inner	2.16				
	Outer		2.37			
	Total			5.38		
Quadrant 3	Inner	2.00				
	Outer		2.12			
	Total			5.38		
Quadrant 4	Inner	2.10				
	Outer		2.30			
	Total			5.41		

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		

[Signature]  
 Inspector

11-21-01  
 Date

X 6.2 Perform a continuity check of the IORS Voltage Taps.

**Limit: No Opens**

Inner	Valhalla Serial Number	Reading	Pass	Fail
Quadrant 1				
Quadrant 2				
Quadrant 3				
Quadrant 4				

N/A  
 Inspector

Date

X 6.3 Perform a Hipot on the Collared Coil Assembly (Maximum Leakage 2.5µA)

5 KV	Measurement(s)
Heater #1/2 to Ground	.8 µA
Heater #2/3 to Ground	.8
Heater #3/4 to Ground	.8
Heater #4/1 to Ground	.8
Heater #1/2 to Coils	.8
Heater #2/3 to Coils	.8
Heater #3/4 to Coils	.8
Heater #4/1 to Coils	.8
All 4 Quadrants to Ground	.5

Coil to Coil 3.0 KV	Measurement(s)
Quadrant 1 to Quadrant 2	1.05 µA
Quadrant 2 to Quadrant 3	.05
Quadrant 3 to Quadrant 4	.05
Quadrant 4 to Quadrant 1	.05

Inspector

Date

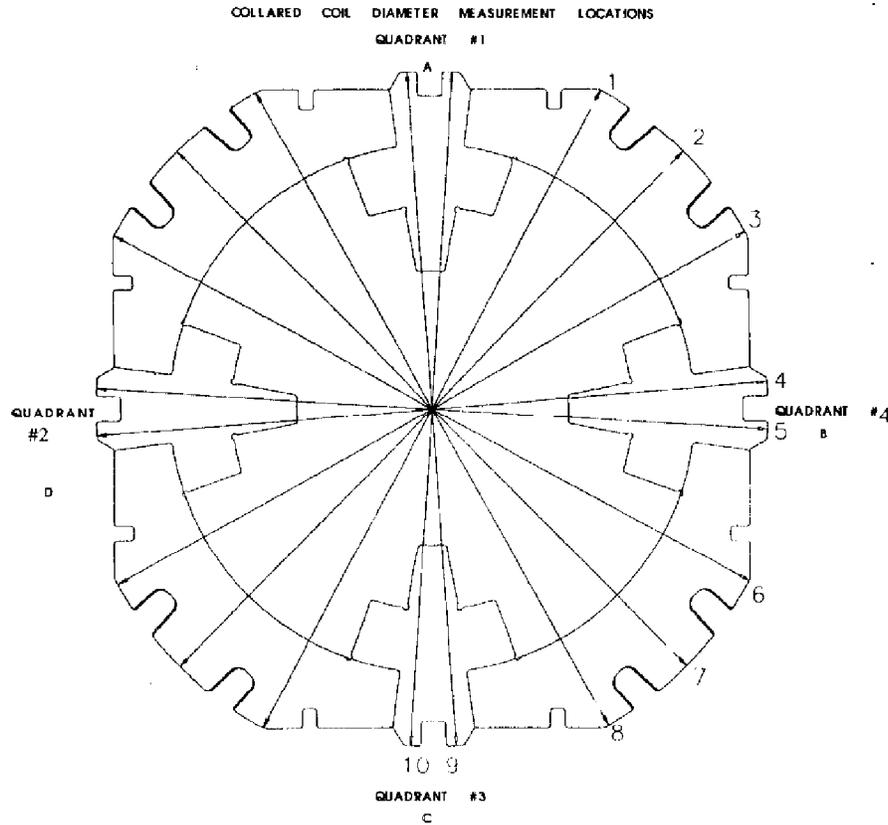


6.4 Verify that the readings in Step 6.0 are acceptable. Approved for next Major Assembly Procedure.

Responsible Authority/Physicist

Date

7.0 Diameter Measuring Procedure (ES-344697).



**Looking from the Lead End**

- 7.1 Using the Collared Coil Assembly Measuring Fixture, measure and record the dimension across the Collared Coil Assembly as shown at points 2, 4, 5, 7, 9 and 10.
- 7.2 Measurements are taken across the laminations.
- 7.4 Start at the Lead End of the Collared Coil Assembly.
- 7.5 Measurements along the length of the Collared Coil Assembly shall be taken at the Center of each lamination pack.
- 7.6 Insert computer printout of measurement at this page of the traveler.
- 7.7 Send an electronic copy of the computer-collected data to the Samsats II folder.

Inspector

Date

8.0 Production Complete

8.1 Process Engineering verify that the LHC Collared/Keying Traveler (5520-TR-333495) 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:

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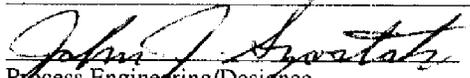
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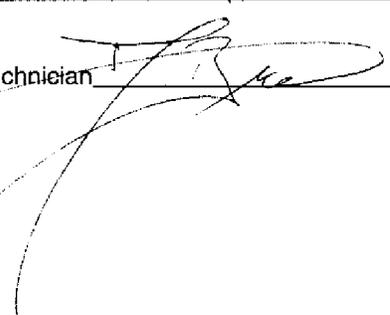
  
Process Engineering/Designee

11/7/03  
Date

# MQXBC-02

(After rekeyeing)

Le to Re	Le to Re	Le to Re	Le to Re	Le to Re	Le to Re
Pos#2	Pos#4	Pos#5	Pos#7	Pos#9	Pos#10
0" 7.283	6.798	6.794	7.282	6.795	<b>6.795</b>
6" 7.278	6.788	6.788	7.276	6.785	6.790
12" 7.276	6.789	6.789	7.277	6.786	6.791
18"					
24"					
30"					
36"					
42"					
48"					
54"					
60"					
66"					
72"					
78"					

Technician 

Date 11-21-01

Revision Request Control Number: 1254

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

Traveler or Document Title LHC End Can Installation Traveler

Step #/Description of Revision:

- 8.5 Modified Step. Changed HiPot Table. Heaters grounded for Coil to Ground check. Coil grounded for Heaters to Ground check. Added Pictures. DR No. HGQ-0282.
- 10.1 Modified Step. Thick wall of plate should be on the INSIDE.
- 10.2 Modified Step. Thick wall of plate should be on the INSIDE.
- 11.2 Added Step. Perform a Ring as per (ES-344799).

Jim Rife

Originator

Matt Cullen

Responsible Authority

11/21/2001

Date

Revision Incorporated into the Traveler:

John Szostak

Revision Incorporated By

11/21/2001

Date

Process Engineering Final Review:

Bob Jensen

Process Engineering/Designee

11/21/2001

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.