Princeton Plasma Physics Laboratory
Procedure

Procedure Title: **Modular Coil Lead Repair-Part 2 Repair**

Number:	Revision:	Effective Date: **July 28, 2006**
D-NCSX-RP-STEL-058	**00**	Expiration Date: *(2 yrs. unless otherwise stipulated)*

Procedure Approvals

Author: Tom Meighan: James H. Chrzanowski
Digitally signed by James H. Chrzanowski
DN: CN = James H. Chrzanowski, C = US, O = PPPL, OU = Engineering
Reason: I am the author of this document
Date: 2006.07.28 15:09:46 -04'00'

ATI: Jim Chrzanowski: James H. Chrzanowski
Digitally signed by James H. Chrzanowski
DN: CN = James H. Chrzanowski, C = US, O = PPPL, OU = Engineering
Date: 2006.07.28 15:09:51 -04'00'

RLM: Larry Dudek: Larry Dudek
Digitally signed by Larry Dudek
DN: cn=Larry Dudek, c=US
Date: 2006.07.31 09:47:02 -04'00'

Responsible Division: **NCSX Project**

Procedure Requirements
Designated by RLM

LABWIDE:

	Work Planning Form # WP-1138 (ENG-032)		Lockout/Tagout (ESH-016)
	Confined Space Permit (5008,SEC.8 Chap 5)	**X**	Lift Procedure (ENG-021)
	Master Equip. List Mod (GEN-005)	**X**	ES&H Review (NEPA, IH, etc.) NEPA 1224
	RWP (HP-OP-20)		Independent Review
	ATI Walkdown	**X**	Pre-Job Brief
X	Post-job Brief *		

D-SITE SPECIFIC:

X	D-Site Work Permit (OP-AD-09)		Door Permit (OP-G-93)
	Tritium Work Permit (OP-AD-49)		USQD (OP-AD-63)
X	Pre-Job Brief (OP-AD-79)		T-Mod (OP-AD-03)
	** DCA/DCN (OP-AD-104) # _____		

- Required for installations involving internal vacuum installations, critical lifts, and for the initial installation of repetitive work.

** OP-AD-104 was voided by procedure ENG-032. However, DCAs that were open at the time of adoption of ENG-032 are still considered valid for work approval purposes.

Modular Coil Lead Repair-Part 2 Repair
D-NCSX-RP-STEL-058-00

REVIEWERS (designated by RLM)		
Accountable Technical Individual ……	**Steve Raftopoulos**	
Test Director		
Independent Reviewer …….	**Hutch Neilson, Mike Williams**	**XX**
D-Site Shift Supervisor ……		
NSTX ……..		
Electrical ……..	**Raki Ramakrishnan, Bob Marsala**	**X**
Vacuum		
Computer		
Field Supervisor /Test Director	**Tom Meighan**	**X**
Quality Assurance/Quality Control ……	**Colin Phelps**	**X**
AC Power		
Maintenance and Operations Division		
Energy Conversion System/Motor Control Division		
D & D Rad Waste / H.P Coordinator……		
Environmental Restoration & Waste Management Division		
Water		
Neutral Beam (Heating Systems Branch of Electrical Engineering)		
Radiofrequency (Heating Systems Branch of Electrical Engineering)		
Diagnostics		
Environmental, Safety & Health ……		
Industrial Hygience……..	**Neil Gerrish**	
Health Physics……		
RLM……..	**Larry Dudek**	**X**

TRAINING (designated by RLM)			
No training required _____ Instructor _Jim Chrzanowski			
Personnel (group, job title or individual name)	Read Only	Instruction **Pre-job Briefing**	Hands On
Technicians performing task		**x**	
Training Rep.			
RLM **Larry Dudek**			

Modular Coil Lead Repair-Part 2 Repair
D-NCSX-RP-STEL-058-00

1.0 PURPOSE

This procedure will describe the precautions and steps required to repair and seal the Type "C" modular coil lead block area after diagnosis has been completed.

2.0 SCOPE

This procedure will include:

2.1 Prerequisites prior to starting work
2.2 Steps for moving the coil so that the lead block is positioned optimally for the repair.
2.3 Steps for repairing the defects in the lead block region.
2.4 Steps for testing/validating the repair prior to seal.
2.5 Steps for sealing the lead block area.
2.6 Steps for testing/validating the repair after the lead block is sealed.

3.0 REFERENCE DOCUMENTS

3.1 ESHD-5008, Environmental, Safety and Health Manual
3.2 D-NCSX-931 Lift Procedure

4.0 PREREQUISITIES & ES&H ISSUES

4.1 The ATI or his designee will hold a pre-job briefing. This meeting will include a discussion of the hazards associated with this repair via the Job Hazard Analysis (JHA) sheet. The meeting shall be documented with attendance sheets forwarded to the Training Office.

Pre-job Briefing complete: _____ Date: _____
ATI/Designee

4.2 Use appropriate Personnel Protective Equipment as outlined in the JHA and procedure.

4.3 Using lift procedure D-L-NCSX-983, orient coil so that lead block is facing up.

5.0 REPAIR PROCEDURE

5.1 This repair will be performed under the supervision of the Repair Director. The Repair Director, upon notifying the ATI and/or the RLM, has the authority to re-arrange the order of the steps if his observations during the repair warrant such re-arrangement.

Repair Director for this procedure:_____

RLM Acceptance: _____

5.2 **ENSURE** that all chill plate/cladding tubes, flux loops and strain gage wires are shorted together and grounded to the casing. **ENSURE** that the casing is shorted to building ground.

Verified: _____ Date: _____
Repair Director

5.3 During repair work, **COVER** any exposed flux loop with blue vinyl tape in order to protect the diagnostic flux loops that exit the lead box on both sides of the coil.

Verified: _____ Date: _____
Repair Director

5.4 REMOVAL OF CHILL PLATES

- **SAFETY NOTE:** Safety glasses **MUST** be worn when performing the steps that involve cutting, removing and bending of copper plates.

5.4.1 **PERFORM** initial Megger test by:

- **SAFETY NOTE:** High voltage gloves and an insulating mat **MUST** be used when performing the steps that involve the Megger test.

5.4.1.1 **SHORT** the terminals with section of welding cable or heavy duty clip leads.
5.4.1.2 **APPLY** voltage in gradual steps (1000 volt steps). **HOLD** at 5kV for one minute.
5.4.1.3 **MEASURE** and **RECORD** the resistance to ground.

Voltage Applied (KV)	Insulation Resistance (MΩ)	Comments
500V		
1kV		
2kV		
3kV		
4kV		
5kV		

Instrument model number: _____

Instrument serial number: _____

Calibration date: _____

Coil/Ambient temperature (degrees Centigrade):_____

Ambient Humidity:_____

5.4.2 **MASK** off the surrounding area around the chill plate fingers with duct tape and plastic. See figure 1.

5.4.3 Straighten the cladding fingers in location A that lock the cladding and chill plates.

5.4.4 Using tin snips and clippers **CUT** the Cladding plate fingers back so that once the fingers are re-bent the tabs on opposite sides of the septum **DO NOT** touch. [Location A]

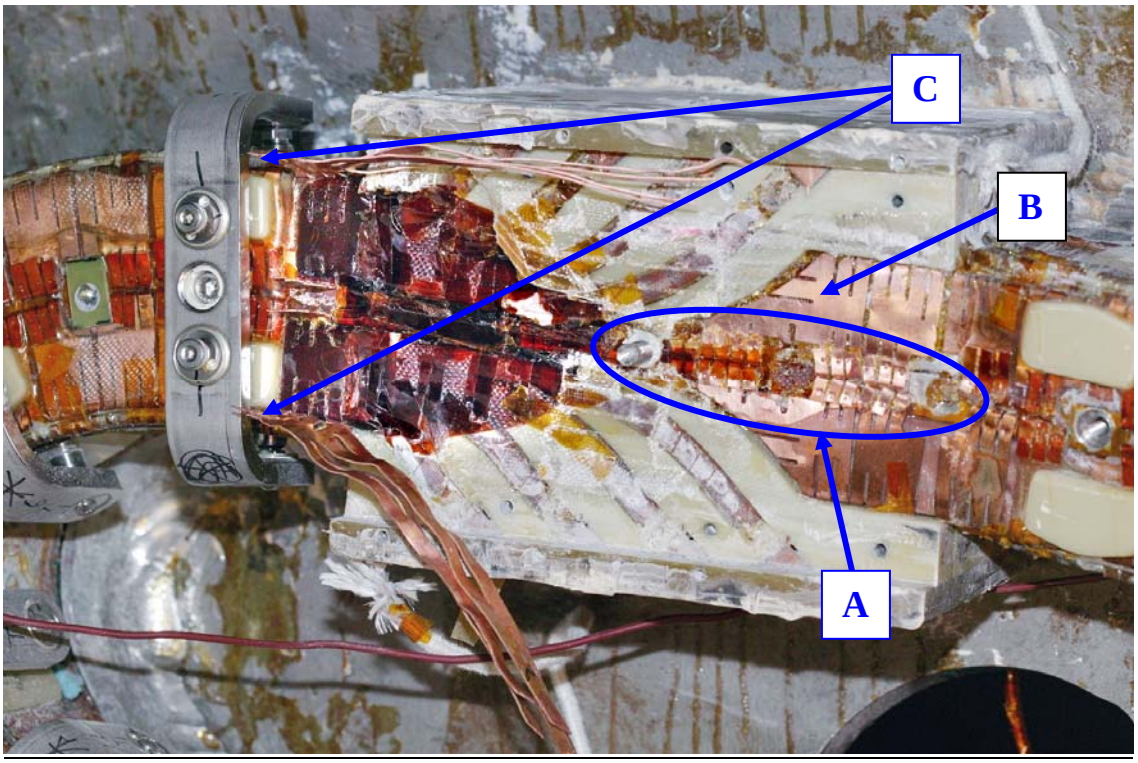

Figure 1- Lead Repair Area

5.4.5 At location B, flatten the chill plate that is bowed. EXTREME care should be taken not to damage the coil turns.

5.4.6 At location A, **CUT** the Chill Plate fingers so that approximately ¾" extends above the coil pack.

5.4.7 **DRESS** edges of the newly cut copper tabs with a file so that edges are smooth. **USE** a vacuum cleaner to capture filings.

5.4.8 At location C **BEND** the inner tabs inward toward the center of the septum wall. **USE** adhesive backed Kapton to ensure that tabs remain electrically isolated from the septum.

5.4.9 At location A, **FOLD** and rejoin the cladding and chill plates. Ensure that the cladding does not touch the cladding on the opposite side of the septum.

5.4.10 To ensure that the insulation resistance hasn't changed after bending the tabs, **MEGGER** the coil to 500VDC for 1 minute using the Fluke mega-ohm meter and record the resistance.

- **SAFETY NOTE:** High voltage gloves and an insulating mat **MUST** be used when performing the steps that involve the Megger test.

5.4.10.1 SHORT the terminals with section of welding cable or heavy duty clip leads.

5.4.10.2 MEASURE and **RECORD** the resistance to ground.

Voltage Applied (KV)	Insulation Resistance (MΩ)	Comments

Instrument model number: _____

Instrument serial number: _____

Calibration date: _____

Coil/Ambient temperature (degrees Centigrade):_____

Ambient Humidity:_____

5.4.11 Megger tests acceptable - **PROCEED** to repair section 5.5.

Verified: _____ Date: _____
Repair Director

5.5 REPAIR/SEALING OF DRY AREAS

- **SAFETY NOTE:** Chemical goggles and heavy nitrile gloves **MUST** be worn when performing the steps that involve the use of epoxy.

5.5.1 Using the original lid, **PERFORM** a trial fit. This should include the glass/kapton and the lid. **DETERMINE** how much (if any) of the material from the bottom side of the lid should be removed so that the insulating materials **WILL NOT** be compressed more that 10 percent when the lid is installed.

5.5.2 **APPLY** adhesive backed Kapton tape and mold release spray to the bottom side of the lid **EXCEPT** to the edges of the lid that seal against the sides of the lead block box.

5.5.3 **DAM** off surrounding the repair area so that epoxy will not run off when it is applied to the coil surface.

5.5.4 **APPLY** a thin coating of CTD-540 epoxy to all dry locations.

5.5.5 Using short strips of glass cloth **COVER** all cut tabs and **SEAL** with CTD-540 epoxy (room temperature cure).

5.6 WET LAYUP OF LEAD BLOCK

5.6.1 Using a combination glass cloth strips and glass/kapton strips soaked in CTD-540, **SEAL** the lead block area.

5.6.2 Using a brush, (if necessary) **APPLY** a thin coat of CTD-540 epoxy to glass cloth.

5.6.3 **INSTALL** the lid being careful not to compress the wet lay-up more than 10 percent by height. If it appears to be over compressed **REMOVE** appropriate layer(s) of glass cloth. Do not remove the glass/kapton layer.

5.6.4 **ALLOW** 24 hours to dry.

6.0 FINAL TESTING OF MODULAR COIL

6.1 DC RESISTANCE

6.1.1 **REMOVE** (if in place) the welding cable that shorts the terminals of the coil.

6.1.2 Using a Digital Low Resistance Ohm Meter (DLRO), **MEASURE** the resistance across the terminals of the coil. **RECORD** value below.

Instrument model number: _____

Instrument serial number: _____

Calibration date: _____

Coil temperature (degrees Centigrade):_____

Resistance (mOhms):_____

6.2 INDUCTANCE TEST

6.2.1 **REMOVE** (if in place) the welding cable that shorts the terminals of the coil.

6.2.2 **SET** meter to measure inductance and **RECORD** the following:

6.2.2.1 The inductance across the terminals of the coil.
6.2.2.2 The inductance across each individual leg from its crossover connector to both "A" and "B" side terminals.

Measurements	Inductance	Comments
Terminal "A" to terminal "B"		
Leg "1" to terminal "A"		
Leg "2" to terminal "A"		
Leg "3" to terminal "A"		
Leg "4" to terminal "A"		
Leg "1" to terminal "B"		
Leg "2" to terminal "B"		
Leg "3" to terminal "B"		
Leg "4" to terminal "B"		

6.2.3 **SET** meter to measure capacitance and record the following:

6.2.3.1 The capacitance from the conductor terminals "A" and "B" to the coil winding form. (*The values for these two measurements should be identical*)

Measurements	Capacitance	Comments
Terminal "A" to Winding Form		
Terminal "B" to Winding Form		
Leg "2" to terminal "A"		

Instrument model number: _____

Instrument serial number: _____

Calibration date: _____

Inductance (H):_____

6.3 MEGGER TEST

- **SAFETY NOTE:** High voltage gloves and an insulating mat **MUST** be used when performing the steps that involve the Megger test.

6.3.1 **USE** the same instrument to perform this test that was used in step 5.4.1

6.3.2 **SHORT** the terminals with section of welding cable or heavy duty clip leads.

6.3.3 **APPLY** voltage in gradual steps (~500 to 1000 volt steps). **HOLD** at 5kV for one minute and at 7.5kV for one minute.

6.3.4 **MEASURE** and **RECORD** the resistance to ground.

Voltage Applied (KV)	Insulation Resistance (MΩ)	Comments
500V		
1kV		
2kV		
3kV		
4kV		
5kV		
6kV		
7.5kV		

Instrument model number: _____

Instrument serial number: _____

Calibration date: _____

Coil/Ambient temperature (degrees Centigrade):_____

Ambient Humidity:_____

6.4 POLARIZATION INDEX TEST

- **SAFETY NOTE:** High voltage gloves and an insulating mat **MUST** be used when performing the steps that involve the Megger test.

6.4.1 **SHORT** the terminals with section of welding cable or heavy duty clip leads.

6.4.2 **APPLY** voltage in gradual steps (~500 to 1000 volt steps). **HOLD** at 5kV (max voltage allowed for this test).

6.4.3 **RECORD** the leakage current after one minute and after ten minutes.

Voltage Applied (KV)	Leakage Current	Comments
5kV for 1 minute		
5kV for 10 minute		

Instrument model number: _____

Instrument serial number: _____

Calibration date: _____

Coil/Ambient temperature (degrees Centigrade):_____

Ambient Humidity:_____

7.0 PROCEDURE COMPLETION

7.1 ***All work has been performed in accordance with this procedure.***

7.2 All notes, observations and data sheets will be appended to this procedure document as permanent record. This procedure will be placed in the coil field package of the coil being repaired.

All work has been performed in accordance with this procedure.

Repair Director Signoff: _____ Date: _____

Quality Control Verify: _____ Date: _____

Field Supervisor: _____ Date: _____