

**Appendix O**  
NSTX OH Fault Corrective Action Plan  
**NSTX OH Fault**  
**Corrective Action Plan**  
**Rev. 1**



Reviewed by: \_\_\_\_\_  
M. Ono



Digitally signed by Jonathan Menard  
Date: 2015.08.01 13:37:19 -04'00'

Reviewed by: \_\_\_\_\_  
J. Menard

Ronald L.  
Strykowski

Digitally signed by Ronald L. Strykowski  
DN: cn=Ronald L. Strykowski, o=Princeton  
Plasma Physics Laboratory, ou=PPPL,  
email=rstrykow@pppl.gov, c=US  
Date: 2015.08.02 13:13:19 -04'00'

Reviewed by: \_\_\_\_\_  
R. Strykowski

Alfred von Halle

Digitally signed by Alfred von Halle  
DN: cn=Alfred von Halle, o, ou,  
email=avonhalle@pppl.gov, c=US  
Date: 2015.08.03 06:33:05 -05'00'

Reviewed by: \_\_\_\_\_  
M. Williams

Adam Cohen

Digitally signed by Adam Cohen  
DN: cn=Adam Cohen, o=Princeton  
University, ou=PPPL,  
email=acohen@pppl.gov, c=US  
Date: 2015.08.02 21:51:44 -04'00'

Reviewed by: \_\_\_\_\_  
A. Cohen

Stewart Prager

Digitally signed by Stewart Prager  
DN: cn=Stewart Prager, o=Princeton Plasma  
Physics Laboratory, ou=Director,  
email=sprager@pppl.gov, c=US  
Date: 2015.08.02 22:04:41 -04'00'

Approved by: \_\_\_\_\_  
S. Prager

# Appendix O

## NSTX OH Fault Corrective Action Plan (continued)

### Background:

On April 24, PPPL ESU responded to alarms from the NSTX-U experimental area. An active water leak from NSTX-U was observed. Staff discovered that several of the Ohmic Heating coils external cooling paths were damaged at the top end of the OH coil. Additionally, indications of electrical arcing were observed in the vicinity of the water leaks. Initial inspection showed no damage to the OH or other coil systems. The water was secured and investigation into the cause was initiated.

### Review Teams:

As a result of this event, the Laboratory has commissioned a number of reviews to evaluate the cause, determine what actions are necessary to repair the coil, what actions are necessary to improve processes and prevent recurrence. The following teams were commissioned:

- An Internal Independent Review team, comprised of: Robert Ellis, Chair, Michael Bell, John DeLooper, Joel Hosea, and Charlie Neumeyer conducted a formal review on May 8. Their report, issued on May 12, identified 32 recommendations. The recommendations for this report are labeled as no's 1 (IRR) through 32 (IRR).
- The PPPL Advisory Board met on May 13 and 14 and were given a summary of the event. Their report, issued May 15, identified 3 recommendations. The recommendations for this report are labeled as no's 33 (PAC) through 35 (PAC).
- An Extent of Condition Review Team, comprised of: J. Hosea, chair, R. Ellis, N. Greenough, D. Mueller, issued their report on May 26, with 25 recommendations. The recommendations for this report are labeled as no's 36 (EOC) through 60 (EOC).
- An Independent External Review Team, comprised of: Arnie Kellman, chair, General Atomics; Jim Irby, MIT Plasma Fusion Center; Brad Merrill, Idaho National Laboratory; and George Ganetis, Brookhaven National Laboratory issued their report on May 28, with 14 recommendations. The recommendations for this report are labeled as no's 61 (IER) through 75 (IER). *Note that item 75 was in error and is not associated with any recommendation.*
- *A formal Root Cause Analysis Team, comprised of Irving Zatz, John Lacenere, Judy Malsbury and Mike Mardenfeld was commissioned. This report identified some 20 Judgements of Need (JONs). These JONs are labeled as no's 76 (JON) through 95 (JON)*

### Corrective Actions:

Since many of the recommendations were related, this corrective action plan groups the recommendations into major areas for action and tracks the items by these groupings.

This plan also specifies which actions need to be done before CD-4 and which can be accomplished after CD-4. Category A corrections must be done before CD-4 while Category B actions can be actions can be accomplished subsequently.

Revision 0 Original Issue

Revision 1 Added Judgements of Needs (JONs) from Root Cause Analysis Report and updated status column as of July 30, 2015

## Appendix O

### NSTX OH Fault Corrective Action Plan (continued)

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
1	A	1 (IR)	Determine the root cause of the ground plane connector design/installation errors [Separate committee using procedure QA-019]	1-1 Form a team to Conduct a Root Cause Analysis per QA-019 before CD-4 1-2 Complete Root Cause Analysis report 1-3 Incorporate recommendations (Judgments of Need) into this CAP	Zatz	OPEN (Root Cause Rpt, rev 0 issued; rev. 1 of this CAP will allow closure)
		20 (IR)	Complete root cause analysis and be prepared to present to external committee			
		64 (IER)	A Root Cause Analysis must be delivered to the ACC prior to approval of restart of high power test operations.			
		34 (PAC)	Ensure that PPPL identifies and addresses the correct fundamental root causes and complete extent of conditions for the external review committee to validate			

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
1A	B	1 (IR)	Determine the root cause of the ground plane connector design/installation errors [Separate committee using procedure QA-019]	Issue Revision 1 of Root Cause report with attachments. Review for any further updates of this CAP	Zatz/Williams	OPEN

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
2	A	15 (IR)	The project needs to develop a comprehensive plan to address the Extent of Condition charge question and be ready to present to the external review committee	Extent of Condition committee was formed. Their report was issued May 26. The recommendations from that report have been incorporated into this corrective action plan.	Hosea	Closed - 5/26/15
		16 (IR)	Form a small "task force" (with appropriate expertise) to walk down all the high-voltage parts of NSTX-U to determine anything out of the ordinary, or potentially questionable from an "high voltage hygiene" stand-point			
		17 (IR)	Evaluate other gaps, creepage paths, and insulation on other coils and appendages to see if problems exist similar to OH			
		33 (PAC)	Evaluate PPPL conduct of engineering and conduct of operations policies and the execution of those policies, roles and responsibilities, accountability and authority, and organization, as part of the extent-of-conditions task force review. Include interviews with engineering and NSTX operations staff			

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
3	A	2 (IR)	Continue to perform diagnostic electrical tests including repeat of coil resistance measurement, inductance measurement and impulse test to confirm that the turn-to-turn insulation is intact	Conduct tests per PTPs and ISTP for restart. Engineering will determine which portions of the PTP's and ISTP need to be rerun once the machine is reassembled.	von Halle	OPEN #2 closed #68 closed #73 closed
		65 (IER)	An impulse test should be done to fully qualify the OH coil			
		68 (IER)	The inner and outer vessel Hi-Pols must be successfully completed before returning to CD-4			
		73 (IER)	Careful attention must be paid to the recommissioning of the machine after the recovery effort. It may be best to err on rechecking more systems than less since some things may have been inadvertently affected during disassembly.			

EOC = Extent of Condition, IER = Independent External Review, IIR = Internal Independent Review, JON = Judgment of Need from Root Cause Analysis, PAC = PPPL Advisory Committee

## Appendix O

### NSTX OH Fault Corrective Action Plan (continued)

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
4	B	18 (IIR)	Analyze and document electrical effect of Aquapur and dental floss wires in gap between OH and TF	Calculations complete being reviewed. No changes anticipated	Titus	Closed - 7/7/15
		56 (EOC)	Aquapur/Epoxy between TF inner bundle and OH Center Stack - Operation of OH and TF combined with PLC controlled water heater to program the water temperature profile; Controlled through DCPS using I <sup>2</sup> t; Constrains the pulse repetition rate.			
5	A	6 (IIR)	Determine NSTX-U project line of authority - who must approve proceeding with operations if causes of ground fault (or other problem causing a trip) have not been determined and resolved	<p>Project will determine appropriate lines of authority, roles and operational methodology for off normal events and then define in an administrative procedure</p> <p>new administrative procedure will be put in force to define the expected responses for each of the full set of protection systems. This will include directions to get approvals from the appropriate subject matter experts from engineering, research, and management. Key control room personnel will be trained on the requirements of this procedure.</p> <p><b>The procedure for the D---Site Control of System Status (Chain of Command), OP---AD---56, will be revised and approved</b></p>	Ono/Menard/von Halle/Williams	<p>OPEN</p> <p>#4 - Closed</p> <p>#6 - Closed</p> <p>#8 - Closed</p> <p>#10 - Closed</p> <p>#35 - Closed</p> <p>#60 - Closed</p> <p>#81 - Closed</p>
		8 (IIR)	The Laboratory should determine whether the operators (e.g. COEs) report up to and through the NSTX-U organization rather than engineering			
		10 (IIR)	Project needs to demonstrate how it will prevent this type of management control failure from recurring in the future			
		60 (EOC)	Chain of command during operations. -Clear line of command to and from the COE during off-normal events			
		4 (IIR)	Revise operational procedures to require a full stop of operations upon a ground fault trip - need to understand what went wrong - require inspectors to determine reason completed prior to restart of testing. This must address the control room conduct of operations including required personnel, the amount of discretion that operations personnel have in continuing a given test campaign, i.e. when can protection systems be bypassed. Operations must stop until a serious fault condition is understood before proceeding.			
		61 (IER)	Reinforce workforce authority to stop work, especially when anomalies are observed			
		35 (PAC)	The Chain of Command for Control of Equipment and System Status, defined in OP-AD-56, failed to prevent the event and needs to be reviewed and corrected.			
		93 (JON 19)				

EOC = Extent of Condition, IER = Independent External Review, IIR = Internal Independent Review, JON = Judgment of Need from Root Cause Analysis, PAC = PPPL Advisory Committee

# Appendix O

## NSTX OH Fault Corrective Action Plan (continued)

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
6	A	5 (IIR)	COEs should have a collection of MDS Scope pages set up to monitor critical operations and diagnose faults under operations procedure. The pages used should be optimized for the type of operation underway (test shot, ISTP, plasma ops, etc.)	<p>6-1 Develop and implement scope pages for PS EICs and COEs. Some optimization of critical info necessary to avoid overload</p> <p>6-2 The available MDS scope pages will be evaluated and documented for use by key control room personnel.</p> <p>6-3 Control Room personnel will be trained on their use.</p> <p>6-4 Adequacy of COE station computers and displays will be reviewed with the COE's and appropriate updates made</p>	von Halle	OPEN
		67 (IER)	The signals from all ground fault signals should be digitized and made easily displayable by the operations group.			
		58 (EOC)	Adequacy of control room computers and associated displays for the COE.			
		72 (IER)	Improvement in instrumentation to aid in identification of causes of off-normal events should be addressed. This is true not only for ground faults, but any signals that provide interlocks for serious machine shutdown conditions.			

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
7	B	14 (IIR)	Engineering needs to establish rules for grounding each experimental machine as part of the formal design review process	<p>7-1 A formal grounding policy will be developed and deployed as well as a SME for grounding will be appointed</p> <p>7-2 The PPPL System Engineer list will be reviewed and updated to include an equipment grounding Subject Matter Expert who will provide engineering input in establishing this policy</p>	von Halle	OPEN
		63 (IER)	A policy for equipment grounding must be developed			

EOC = Extent of Condition, IER = Independent External Review, IIR = Internal Independent Review, JON = Judgment of Need from Root Cause Analysis, PAC = PPPL Advisory Committee

## Appendix O

### NSTX OH Fault Corrective Action Plan (continued)

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
8	A	3 (IIR)	The design of the OH ground plane and its connections needs to undergo the standard PPPL design review, installation and inspection process, rather than relying on a "field fit-up."	8-1 Assure that all design changes undergo as a minimum, a final design review, per ENG-032  8-2 Assure that all appropriate design documentation is placed in the Operations Center	Dudek	OPEN #3 – Closed #11 – Closed #13 – Closed #70 – Closed #74 – Closed
		11 (IIR)	Project needs to verify design documentation packages (GDR, PDR, FDR) are available in the operations center for the NSTX-U centerstack and beamline 2			
		13 (IIR)	Incorporate electrical analysis and design into development of upgraded components			
		62 (IER)	A systematic check of all installation packages for NSTX-U must be performed with the object of identifying any other field installations and then evaluating whether they were installed properly. This review team should include at least the cognizant engineer and installation technician.			
		70 (IER)	Complete implementation of design changes identified by the team			
		74 (IER)	Assuming design reviews are properly completed, as per normal PPPL procedure, and installation process is carefully reviewed and inspected, the committee believes that the reassembly of the machine can proceed			

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
9	B	32 (IIR)	Consider installing real-time camera(s) and arc flash detectors inside hub assemblies	Will evaluate and determine feasibility – incorporate post CD4	Dudek	OPEN October 15, 2015.
		59 (EOC)	Add cameras for real-time viewing of critical machine components			

EOC = Extent of Condition, IER = Independent External Review, IIR = Internal Independent Review, JON = Judgment of Need from Root Cause Analysis, PAC = PPPL Advisory Committee

## Appendix O

### NSTX OH Fault Corrective Action Plan (continued)

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
12	A	26 (IIR)	For new design of clamps that support OH water lines: ensure adequate gaps, creepage, and insulation to pass hipot at 1.5 x Voh. Hipot, use insulating boot, over water line as it emerges from coil, do not use metallic screws; avoid splits in G10 blocks that provide line of sight creepage path	New design has been developed with input from electrical engineers. Design subjected to final design review and then issued to field for construction	Raflopoulos	CLOSED
		29 (IIR)	Evaluate whether or not method for clamping of OH water fittings allows for radial expansion of coil copper while support structure remains fixed, without placing undue stress on the water fittings. Consider placing a bend in the water fitting to avoid this issue			
		41 (EOC)	OH Water Connections: •Need an approved design with proper insulation - underway – Original parts were field fit. –New design must have electrical engineering input to insure proper high voltage insulating techniques - underway. Properly insulated the water cooling tubes while maintaining the ability to detect water leaks			
		71 (IER)				

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
13	B	23 (IIR)	Consider scheme to monitor load impedance in PSRTC (and/or DCPS) to sense situations where coil has become degraded	Code revised, tested and implemented	Gerhart	CLOSED

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
14	B	7 (IIR)	Engineering needs to establish a policy for field installations – when does a review have to be completed of field design	Develop field installation policy; Revise WP procedures accordingly. Issue statement of field change policy per PMO procedures to COGs and RLMs. Include in next COG/RLM training. Due 8/1/15	Perry/Stevenson	CLOSED

EOC = Extent of Condition, IER = Independent External Review, IIR = Internal Independent Review, JON = Judgment of Need from Root Cause Analysis, PAC = PPPL Advisory Committee

# Appendix O

## NSTX OH Fault Corrective Action Plan (continued)

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
15	B	54 (EOC)	Bakeout Constraints on Machine Operations: Failure to reach desired 350C bakeout for divertor tiles is predicted. Refer to PF-1A, B, and C considerations; High temperature is needed for bakeout of divertor plates to provide for good plasma performance. Preparations need to be made to add hot He gas heating to the divertor plates to reach desired temperature of 350C. Discoloration of CHI leads after Center Stack bake. Need to understand the cause	15-1 The urgent task is to install bakeout compatible tubes which are accessible from outside the umbrella structure compatible to be installed for the vertical and horizontal divertor sections. This task will be completed prior to CD-4.	Ono/Titus	OPEN
		55 (EOC)	Bakeout Constraints on Machine Operations: Discoloration of CHI leads after Center Stack bake. -Need to understand the cause	15-2 Through realistic thermal modeling and on-going material temperature testing, a bakeout heating scheme will be chosen if any before the bakeout.		
		53 (EOC)	PF1A, 1B, 1C Considerations: Bakeout issue with PF-1B (Art Brooks analysis). Divertor tiles will not reach adequate temperature unless heated by the He system. If heated by He, the G10 spacer and ground wrap of PF-1B will exceed allowable limits. There is also the issue of stress in the welds securing PF-1B upper and PF-1A upper. Management must decide whether to bake to over 300C and accept risks to PF-1B. Connections to divertor plates must be able to accommodate the He heating system.	15-3 Risk- benefit assessment for PF-1B will be performed in deciding the heating system if any before the bakeout. 15-4 The cause of the CHI leads discoloration will be determined prior to the next bakeout 15-5 With the thermo-couple placed on PF-1C, we agree that the excessive heating of PF-1C can be avoided administratively. A clear set of operating constraints will be developed by the start of research operations		

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
16	B	51 (EOC)	PF1A, 1B, 1C Considerations-Shorting between PF-1A ground wrap and OH ground plane. It cannot be repaired without removing center stack. What are the ramifications? Minor.	Since PF-1A ground wrap and OH ground plane are grounded to the same potential, we do not see any ramifications. With the thermo-couple placed on PF-1C, we agree that the excessive heating of PF-1C can be avoided administratively. A clear set of operating constraints will be developed by the start of research operations	Ono/Titus	OPEN
		52 (EOC)	PF1A, 1B, 1C Considerations: PF-1C can be heated by the plasma. Only a minor issue when PF-1B is not energized, but the strike point can still hit the PF-1C can; Energizing PF-1C so as to push the strike point towards the plasma will avoid this; Operations can administratively avoid the problem; A clear set of operating constraints needs to be developed.	operations		

EOC = Extent of Condition, IER = Independent External Review, IIR = Internal Independent Review, JON = Judgment of Need from Root Cause Analysis, PAC = PPPL Advisory Committee



# Appendix O

## NSTX OH Fault Corrective Action Plan (continued)

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
17	B	9 (IIR)	The Laboratory needs to determine whether sufficient high voltage electrical expertise is available for current and future projects	<p>TBD – need meeting to establish long term corrective action – Cohen to call meeting by 9/15/15</p> <p>Succession Plan – Von Halle effort to capture by posting of positions (addresses part of JON 7 and 8)</p>	Cohen	OPEN
		82 (JON 7)	PPP needs to capture the institutional knowledge held by experienced staff and current best practices by creating formal, internal technical standards and ensure that they are readily available and applied uniformly.			
		83 (JON 8)	PPP needs to capture institutional knowledge held by experienced staff by expanding formal training systems for positions requiring critical technical skills that are specific to PPP.			
		84 (JON 9)	PPP needs to evaluate the current skill mix among staff and develop a detailed succession plan.			

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
18	B	12 (IIR)	OH coil hipot level should be 2E+1=2(6+2)+1=17kV per approved design point documentation, which was also checked and signed off by coil designer. If operation requirements are to be revised (e.g. OH <=4kV with CHI, and/or Vchi = 3kV) then relevant documentation should be revised accordingly	Review hi-pot requirements and document accordingly. GRD will be revised to ensure consistency with PTP's.	von Halle	OPEN

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
19	B	19 (IIR)	Consider conducting a "blind spot" review, similar to the laboratory process	Similar approach for Laboratory operations will be evaluated on the NSTXU facility by 10/31/15	Williams	OPEN

EOC = Extent of Condition, IER = Independent External Review, IIR = Internal Independent Review, JON = Judgment of Need from Root Cause Analysis, PAC = PPPL Advisory Committee

## Appendix O

### NSTX OH Fault Corrective Action Plan (continued)

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)					
20	A	21 (IIR)	Ensure that ground plane connection does not form toroidal loop. If hose clamp approach is used to attach ground plane connector, ensure that type, with thermal expansion spring is used. Demonstrate through measurement that the desired resistance is in the loop.	Overall grounding plan will be incorporated in the final design. Required measurements will be taken via procedures and documented. Testing of grounds will become part of the operational procedures. The PPPL System Engineer list will be reviewed and updated to include an equipment grounding. Subject Matter Expert. This engineer or designee will review, approve and inspect equipment grounds. All coil system power feeding into the umbrellastructures should have ground fault sensors to measure any ground leakage current. Ground fault relaying should be provided with ground current sensor measurements and annunciator available in the Control Room.	Rafipoulos/ Dudek	CLOSED					
		22 (IIR)	Consider conducting elastomer solution to ground plane electrical attachment to avoid use of flex copper braid (ref. 13_010220_CLN_01.pdf, 13_010222_CLN_01.pdf, 13_010301_CLN_01.pdf). Provide documentation and drawings to justify and describe solution.								
		25 (IIR)	Measure resistance of ground plane paint to confirm proper application and resistivity (200 ohms/square). Determine if OH ground wall thickness and composition is different than given in design point (as was mentioned during presentation) and provide explanation.								
		28 (IIR)	Connect all metallic structures of inner vacuum vessel to Cat. 3 ground with 10 ohm resistors in each connection that can be opened up for troubleshooting. Provide an approved drawing of the electrical schematic.								
		30 (IIR)	OH ground plane should be connected to Cat. 3 ground reference on both top and bottom ends through 10 ohm resistors. Analysis of ground plane behavior using PSCAD (W. Que "OH-CoilGroundPlaneV3.ppt") should be updated accordingly and properly documented.								
		36 (EOC)	OH ground plane and connection overall design: Do we need a lower ground plane connector? Evaluation is required. Design, fabrication, installation, connection and inspection of ground plane connector(s). Ground through a 10 Ohm resistor.								
		31 (IIR)	Ensure that OH preload assembly fixture is connected to Cat. 3 ground via 10 ohm resistor.								
		37 (EOC)	OH Compression Stack Grounding – Through a 10 Ohm resistor.								
		38 (EOC)	Grounding of buss supports at bottom of machine.								
		39 (EOC)	Grounding of metal spacers to TF water connector supports.								
		40 (EOC)	Who has an overall understanding of the machine grounding? Who is in charge of grounding, inspection thereof, and documentation on NSTX-U? The latter individual should have the qualifications of the former.								
		66 (IER)	Additional ground fault sensors should be added to the new OH ground straps, and the signals made part of a quickly acting ground fault relay. The OH preload stack should be grounded properly and sensors added and their signals recorded.								
		21	B				27 (IIR)	Consider placing water sensor(s) on floor of NSTX-U Test Cell under machine and interlock with water system to turn off pumps.	Will conduct a review to determine benefits and consequences by 10/31/15	Dudek	OPEN

EOC = Extent of Condition, IER = Independent External Review, IIR = Internal Independent Review, JON = Judgment of Need from Root Cause Analysis, PAC = PPPL Advisory Committee

## Appendix O

### NSTX OH Fault Corrective Action Plan (continued)

CAP No.	22	Cat.	A	Recom. No.	57 (EOC)	Issue	Ground fault/loop detector sensitivity lessened by capacitors installed across HFW transmission line DC breaks. Used in the past with the same capacitors. Loop faults are present in the diagnostic ground system.	Actions	Ground fault/loop detector sensitivity reduction due to capacitors installed across the HFW transmission DC breaks has been measured, and the capacitors may now be reinstalled. Known loop faults in the diagnostic ground system need to be evaluated and dispositioned.	Assigned to:	von Halle	Status (as of 7/31/15)	CLOSED
CAP No.	23	Cat.	A	Recom. No.	69 (IER)	Issue	Install Lexan sheets or a similar insulator at the bottom of the machine to make sure that metal objects are not drawn up by the magnetic field into the bus work and connections	Actions	Peer review to determine requirement by June 12, 2015	Assigned to:	Perry	Status (as of 7/31/15)	CLOSED
CAP No.	24	Cat.	B	Recom. No.	73 (IER)	Issue	Although not unique to PPPL and NSTX, we believe that the lab and the fusion community as a whole could benefit from community workshops on best practices in engineering and operations. Discussions concerning measurements of joint resistance (periodic and real-time), ground fault detection highlighted areas in which techniques exist in different fusion and/or DOE labs that would benefit the larger community. While not truly a systemic weakness, such an initiative could strengthen NSTX-U and other device operations and safety.	Actions	Reinstitute Fusion Facilities Operations Committee by 10/1/15.	Assigned to:	Williams	Status (as of 7/31/15)	OPEN
CAP No.	25	Cat.	B	Recom. No.	75 (IER)	Issue	<del>DELETED – NO SPECIFIC RECOMMENDATION WITH THIS ITEM.</del>	Actions	N/A	Assigned to:	N/A	Status (as of 7/31/15)	N/A

EOC = Extent of Condition, IER = Independent External Review, IIR = Internal Independent Review, JON = Judgment of Need from Root Cause Analysis, PAC = PPPL Advisory Committee

## Appendix O

### NSTX OH Fault Corrective Action Plan (continued)

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
26	B	76 (JON 1)	PPPL needs to ensure that a comprehensive Technical Risk Assessment and Management Strategy provides direction for balancing resource allocation with technical assurance. This strategy needs to be appropriately graded for all levels of work.	TBD – need meeting to establish long term corrective action – Cohen to call meeting by 9/15/15	Cohen	OPEN
		85 (JON 10)	PPPL management needs to evaluate if the Laboratory's Organizational Structure inadvertently encourages some of the issues highlighted in the Contributory Causes including staff accountability, staff assignments and competency, information access and communications.			
		86 (JON 11)	PPPL needs to clarify the roles and responsibilities of the Cognizant Engineer, the ATI, and the System Engineer as mentioned in the Work Planning System and Procedures. PPPL needs to ensure that they are being implemented properly, without overlapping or missing coverage.			
		95 (JON 20)	Protections need to be built into PPPL systems to prevent human performance issues from having a negative impact. Clear Goals, Roles, and Responsibilities; Appropriate Checks and Balances; Distinct Problem Solving Skills; Validation of Assumptions; Unfamiliarity with tasks; Recognizing Degraded Proficiency; Technical Stop Work; Inadequate communication.			

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
27	B	78 (JON.3)	PPPL needs to adopt and implement best practices from "Systems Engineering", especially for large complex projects which are composed of many subsystems.	TBD – need meeting to establish long term corrective action – Cohen to call meeting by 9/15/15	Cohen	OPEN
		87 (JON 12)	PPPL needs a rigorous process to ensure that each component or system is assigned to a clearly identified individual who is aware of its current and ongoing status and history, and is someone who is both capable and responsible for its technical aspects.			

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
28	B	77 (JON.2)	PPPL needs to ensure that Lab--wide Procedures are clearly understood, used as a primary resource for directing work, and that they are properly implemented.	TBD – need meeting to establish long term corrective action – Cohen to call meeting by 9/15/15	Cohen	OPEN
		79 (JON.4)	PPPL needs to ensure that the Work Planning System is utilized properly and consistently.			

EOC = Extent of Condition, IER = Independent External Review, IIR = Internal Independent Review, JON = Judgment of Need from Root Cause Analysis, PAC = PPPL Advisory Committee

## Appendix O

### NSTX OH Fault Corrective Action Plan (continued)

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
29	B	80 (JON 5)	PPPL needs to continue to improve existing Project Planning and Control Tools.	TBD – need meeting to establish long term corrective action – Cohen to call meeting by 9/15/15	Cohen	OPEN
		88 (JON 13)	The PPPL Design Review Process needs to be comprehensive, cover all important aspects or components of a work activity, and include all technical disciplines involved in the work activity.			
		88 (JON 14)	During the design phase and after the FDR, the project needs to ensure that the review process extends to as-built configurations including field changes.			
		90 (JON 15)	The Laboratory needs to assure that project specific technical procedures and drawings are appropriately and adequately reviewed.			

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
30	B	81 (JON 6)	PPPL needs to implement an information system (e.g. database) that relates all technical information to allow archiving and access.	TBD – need meeting to establish long term corrective action – Cohen to call meeting by 9/15/15	Cohen	OPEN

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
31	B	91 (JON 16)	An expansion of independent field oversight needs to be implemented.	TBD – need meeting to establish long term corrective action – Cohen to call meeting by 9/15/15	Cohen	OPEN

CAP No.	Cat.	Recom. No.	Issue	Actions	Assigned to:	Status (as of 7/31/15)
32	B	92 (JON 17)	PPPL needs to review and clarify policies for Configuration Control of Experimental Devices to ensure that they are properly implemented with traceability and create adequate documentation of the device.	TBD – need meeting to establish long term corrective action – Cohen to call meeting by 9/15/15	Cohen	OPEN
		93 (JON 18)	Temporary configuration changes need to be formally documented and approved.			

EOC = Extent of Condition, IER = Independent External Review, IIR = Internal Independent Review, JON = Judgment of Need from Root Cause Analysis, PAC = PPPL Advisory Committee