

NSTXU Coil Fault Corrective Action Plan

DRAFT

	Category	Issue	Source	Actions	Actionee
1	A	Determine the root cause of the ground plane connector design/installation errors [Separate committee using procedure QA-019]	Internal Independent Review	Conduct Root Cause Analysis per QA-019	Zatz
2	A	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	Internal Independent Review	Conduct tests per PTPs	von Halle
3	A	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."	Internal Independent Review	Conduct documented Peer Reviews, per ENG-032	Raftopoulos
4	A	Revise operational procedures to require a full stop of operations upon a ground fault trip – need to understand what went wrong – require inspections to determine reason	Internal Independent Review	Revise NSTX operating procedures accordingly	von Halle
5	A	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.)	Internal Independent Review	Develop and implement scope pages for PS EICs and COEs	von Halle
6	B	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	Internal Independent Review		Ono
7	B	Engineering needs to establish a policy for field installations – when does a review have to be completed of field design	Internal Independent Review	Develop field installation policy; Revise WP procedures accordingly	Perry; Stevenson
8	B	The Laboratory should determine whether the operators (e.g. COEs) report up to and through the NSTX-U organization rather than engineering	Internal Independent Review	See #6 above	Ono
9	B	The Laboratory needs to determine whether sufficient high voltage electrical expertise is available for current and future projects	Internal Independent Review		Williams
10	B	Project needs to demonstrate how it will prevent this type of management control failure from recurring in the future	Internal Independent Review	See #6 above	Ono
11	B	Project needs to verify design documentation packages (CDR, PDR, FDR) are available in the operations center for the NSTX-U centerstack and beamline 2	Internal Independent Review		Stevenson

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12	B	OH coil hipot level should be $2E+1=2(6+2)+1=17\text{kV}$ 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 $\leq 4\text{kV}$ with CHI, and/or $V_{chi} = 3\text{kV}$) then relevant documentation should be revised accordingly	Internal Independent Review	Review hi-pot requirements and document accordingly	von Halle
13	A	Incorporate electrical analysis and design into development of upgraded components	Internal Independent Review	See #3 above	Raftopoulos
14	B	Engineering needs to establish rules for grounding each experimental machine as part of the formal design review process	Internal Independent Review	Develop NSTX-U machine grounding policy	Neumeyer
15		The project needs to develop a comprehensive plan to address this charge question and be ready to present to the external review committee	Internal Independent Review		
16	A	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	Internal Independent Review	Addressed as part of Extent of Condition committee	Hosea
17	A	Evaluate other gaps, creepage paths, and insulation on other coils and appendages to see if problems exist similar to OH	Internal Independent Review	Addressed as part of Extent of Condition committee	Hosea
18	B	Analyze and document electrical effect of Aquapour and dental floss wires in gap between OH and TF	Internal Independent Review		Titus
19	B	Consider conducting a "blind spot" review, similar to the laboratory process	Internal Independent Review		
20	A	Complete root cause analysis and be prepared to present to external committee	Internal Independent Review	See #1 above	Zatz
21	A	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	Internal Independent Review	See 33 above	Raftopoulos

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22	A	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	Internal Independent Review	See #3 above	Raftopoulos
23	B	Consider scheme to monitor load impedance in PSRTC (and/or DCPS) to sense situations where coil has become degraded	Internal Independent Review		Gerhart
24	A	Review design of OH lead assembly: confirm cross sectional area of (+) and (-) conductors is equal; confirm that assumptions in design analysis are reflected in as-built configuration; confirm that insulation strength is good for at least 1.5 x Voh_hipot	Internal Independent Review		Dudek
25	A	Measure resistance of ground plane paint to confirm proper application and resistivity (200 ohms/square). Determine if OH groundwall thickness and composition is different than given in design point (as was mentioned during presentation) and provide explanation	Internal Independent Review		Dudek
26	A	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	Internal Independent Review	See #3 above	Raftopoulos
27	B	Consider placing water sensor(s) on floor of NSTX-U Test Cell under machine and interlock with water system to turn off pumps	Internal Independent Review		Dudek
28	A	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	Internal Independent Review	See #3 above	Raftopoulos
29	A	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	Internal Independent Review	See #3 above	Raftopoulos

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30	A	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 "OHCoilGroundPlaneV3.ppt") should be updated accordingly and properly documented	Internal Independent Review	See #3 above	Raftopoulos
31	A	Ensure that OH preload assembly fixture is connected to Cat. 3 ground via 10 ohm resistor	Internal Independent Review	See #3 above	Raftopoulos
32	B	Consider installing real-time camera(s) and arc flash detectors inside hub assemblies	Internal Independent Review		Dudek
33	A	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		Addressed as part of Extent of Condition committee	Hosea
34	A	Ensure that PPPL identifies and addresses the correct fundamental root causes and complete extent of conditions for the external review committee to validate			Williams
35	B	Reinforce workforce authority to stop work, especially when anomalies are observed			Prager/Cohen