



# ENG-033 - CRR - CHIT RESOLUTION REPORT

## Chit Resolution Report for Outer PF Inspection

*NSTXU\_1-1-3-1\_CRR\_101*

Work Planning #:  
Effective Date: **03/10/2020**  
Prepared By: **Chris Pagano**

Reviewed By	Chris Pagano, Cognizant Individual	03/10/2020 12:24:13 PM
Reviewed By	Yuhu Zhai, Project Engineer	03/10/2020 12:26:39 PM
Approved By	Robert A. Ellis, Chief Engineer	03/10/2020 12:37:05 PM



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Prepared By: Chris Pagano, Cognizant Engineer

Reviewed By: Y. Zhai, Project Engineer

Approved By: R. Ellis, Chief Engineer



# Record of Changes

Rev.	Date	Description of Changes
0	03/10/2020	Initial Release

Review	Chit Number	Status
M9.1 Outer PF Inspections PDR	M9.1OUTPFINSP01	Closed
M9.1 Outer PF Inspections PDR	M9.1OUTPFINSP02	Closed
M9.1 Outer PF Inspections PDR	M9.1OUTPFINSP03	Closed
M9.1 Outer PF Inspections PDR	M9.1OUTPFINSP04	Closed
M9.1 Outer PF Inspections PDR	M9.1OUTPFINSP05	Closed
M9.1 Outer PF Inspections PDR	M9.1OUTPFINSP06	Closed
M9.1 Outer PF Inspections PDR	M9.1OUTPFINSP07	Closed
M9.1 Outer PF Inspections PDR	M9.1OUTPFINSP08	Closed
M9.1 Outer PF Inspections PDR	M9.1OUTPFINSP09	Closed
M9.1 Outer PF Inspections PDR	M9.1OUTPFINSP10	Closed
M9.1 Outer PF Inspections PDR	M9.1OUTPFINSP11	Closed

## Outer PF Inspections PDR

Review	ID	Chit
M9.1 Outer PF Inspections PDR	M9.1OUTPF INSP01	To test the turn-to-turn insulation, consider testing with the Elytt surge tester. If both coils have good turn-to-turn insulation, the ringing response of the upper and lower coil of each coil set should be the same when overlayed.

**Closed:** Based on high voltage risks, surge test for the PF 4/5 coil will not be performed.

Review	ID	Chit
M9.1 Outer PF Inspections PDR	M9.1OUTPF INSP02	With regard to the PF-4 flex bus: i) the support for the flex-bus appears to be debated, and ii) maintenance of operations within the RMS current limit is not assured.

**Closed:** The PF-4 bus work has been redesigned, examined, etc, as part of the buswork WBS element. See FDR slides by D. Cai and J. Fang [here](#):

<https://sites.google.com/pppl.gov/20200207pf1culbuspf4andbakeout/presentations>

Review	ID	Chit
M9.1 Outer PF Inspections PDR	M9.1OUTPF INSP03	Consider using a Megger test at 500V or 1000V instead of 2E+1 hipot during thermal cycling to facilitate diagnostic objective with reduced risk of damage prior to coil repairs

**Closed:** The Megger test will be performed at 500 V.

Review	ID	Chit
M9.1 Outer PF Inspections PDR	M9.1OUTPF INSP04	For coil cooling wave testing, need to determine the acceptable heat-up rate to not have "heating wave" issue that might cause worse stress than cooling wave.

**Closed:** The analysis group provided the heat-up rate of 1 degree C per minute. The characteristic cool-down time for the magnet during operations is ~10 minutes; this heating rate will thus induce much smaller thermal stresses than operations. This will allow the temperature to stabilize, and not create unwanted heat stresses on the coil.

Review	ID	Chit
M9.1 Outer PF Inspections PDR	M9.1OUTPF INSP05	Reconsider which tests are performed on which coils. Since PF5 coil is the only one that is suspect, expending resources on the others does not seem justified. This is particularly the case for the thermal cycling that is also of questionable value for PF2,3,4 since the delta T's on those coils is much lower than PF5.

**Closed:** This evaluation was done, as suggested by the chit author. The procedure will test the PF-4 and -5 coils, for the reasons stated.

Review	ID	Chit
M9.1 Outer PF Inspections PDR	M9.1OUTPF INSP06	Perform initial set of tests on sub-coils and ground planes before embarking on thermal cycling tests.  Measure conductivity of ground planes to VV and to neighboring coil ground planes.  Megger each conductor pack to its ground plane.

**Closed:** With regard to the first suggestion, the intent is to do megger testing both before and after thermal cycles.

Regarding the second comment, there is no semi-conducting paint plane against which a measurement can be made. Hence, the coils will be wrapped in aluminum foil during these tests.

As for the third comment, The individual conductor packs will be meggered separately.

Review	ID	Chit
M9.1 Outer PF Inspections PDR	M9.1OUTPF INSP07	For coil cooling wave testing, a more "real-time" impedance measurement that does not require manual intervention would help identify any discontinuous behavior of the coil electrical characteristics as a function of test-condition and time during the thermal testing. Consider using a low-power and low-current (using Crown amplifier?) impedance measurement, i.e. measure V and I to determine Z (can be frequency swept or could use representative fixed frequency or a few frequencies) that is active during the entire testing cycle with data logged frequently.

**Closed:** The Hioki L-C-R meter will be utilized for a frequency sweep from 1 to 20kHz at each temperature range and logged.

Review	ID	Chit
M9.1 Outer PF Inspections PDR	M9.1OUTPF INSP08	I believe that the PF-4 is not pinned at two angles as is assumed in the analysis. While I do not know if this is an issue, it seems that it should qualified, or the field condition should be changed

**Closed:** The Project has committed to implementing the pinning. A successful FDR was held on 01/16/2020, and this scope was added via a BCPs to Project scope under the 6030 control account.

The design can be seen on the [FDR Dashboard https://sites.google.com/pppl.gov/pf4-coil-sup-rad-fdr/home](https://sites.google.com/pppl.gov/pf4-coil-sup-rad-fdr/home)

Review	ID	Chit
M9.1 Outer PF Inspections PDR	M9.1OUTPF INSP09	Early in the presentation, it was inferred that the age of the insulation is a concern and risk. A test log made of "new" materials may not be representative of the condition and risks associated with the "aged" coils on the machine. Can we ensure that a log bend test can simulate the aging that the real coils have undergone.

**Closed:** The Project has not committed to doing a "log" test for the PF-5 coils. If it should choose to do this, then this chit will be a topic of discussion.

Review	ID	Chit
M9.1 Outer PF Inspections PDR	M9.1OUTPF INSP10	Perhaps out of scope for this review, but need to get consistent SAD and GRD and SRDs and DPSS w.r.t. PF4 coil current and bus/cable current and/or rep-rate limits. Should DCPS also include buswork for the coils?

**Closed:** The PF-4 ampacity was at one point unclear, with uncertainty about the capabilities of the flexible bus. This is resolved in the memo MAG\_191118\_SPG\_1, which shows that the SRD requirements can be met, with the circuit component most close to limiting performance being the 1000 kcmil cable that runs from the transition area to the PCTS. The parallel 500 MCM cables in the test cell have more ampacity than the single 1000 kcmil cable.



Review	ID	Chit
M9.1 Outer PF Inspections PDR	M9.1OUTPF INSP11	Consider designing the permanent connection to the PF-5 ground plane before doing the proposed thermal/electrical test. Conducting rubber may be a solution (TBD). This allows the test to be "as we fly".

**Closed:** The PF-5 coil will be wrapped with the aluminum foil as the ground plane during the Megger test. The aluminum foil will be connected to the building ground during the Megger test.