https://lh4.googleusercontent.com/SaZymkchEMjj-FjcX3GoAxt0xK_ctUf7ylzhsi6cxPSXKu1O988rhhG7I-TlvCvRbWkNykOdZuDZEMYNn5lcBmTiDqNifN-9CRSXKKmj8mGERsf4uRgubY-6I_gww53KDpFMYhe2

**Chit Resolution Report**

**for**

**TF/OH Bundle Repair**

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

**(Also includes SBS 1.1.3.3.2)**

Prepared By: A. Falcon, Cognizant Individual

Approved By: Y, Zhai, NSTX-U Project Engineer

Approved By: R. Ellis, Chief Engineer

**Record of Changes**

|  |  |  |
| --- | --- | --- |
| **Rev.** | **Date** | **Description of Changes** |
| 0 | 1/31/2020 | Initial Release |
| 1 | 2/17/2020 | Added Post FDR CHITs |
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**Summary of Chits**

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| **Review** | **ID** | **Status** |
| Magnets DVVR | MTF04 | Closed |
| Magnets DVVR | MTF06 | Closed |
| Magnets DVVR | MTF13 | Closed |
| Magnets DVVR | MTF22 | Closed |
| Magnets DVVR | MTF30 | Closed |
| Magnets DVVR | MTF34 | Closed |
| Magnets DVVR | MTF36 | Closed |
| Magnets DVVR | MTF39 | Closed |
| Magnets DVVR | MOH03 | Closed |
| Magnets DVVR | MOH05 | Closed |
| Magnets DVVR | TFOH02 | Closed |
| Magnets DVVR | TFOH03 | Closed |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR01 | Closed |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR02 | Closed |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR03 | Closed |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR04 | Closed |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR05 | Closed |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR06 | Closed |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR07 | Closed |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR08 | Closed |
| Magnets DVVR | MTF30 | Closed |
| Cooling Water System Interlock PDR | CWSINTPDR01 | Closed |
| Cooling Water System Interlock PDR | CWSINTPDR02 | Closed |
| Cooling Water System Interlock PDR | CWSINTPDR03 | Closed |
| Cooling Water System Interlock PDR | CWSINTPDR04 | Closed |
| Cooling Water System Interlock PDR | CWSINTPDR05 | Closed |
| Cooling Water System Interlock PDR | CWSINTPDR06 | Closed |
| Cooling Water System Interlock PDR | CWSINTPDR07 | Closed |
| Cooling Water System Interlock PDR | CWSINTPDR08 | Closed |
| Cooling Water System Interlock PDR | CWSINTPDR09 | Closed |
| Cooling Water System Interlock PDR | CWSINTPDR10 | Closed |
| Cooling Water System Interlock PDR | CWSINTPDR11 | Closed |
| Cooling Water System Interlock PDR | CWSINTPDR12 | Closed |
| Magnet RP Scope FDR 1 | RPMAGTASK1-01 | Closed |
| Magnet RP Scope FDR 1 | RPMAGTASK1-02 | Closed |
| Magnet RP Scope FDR 1 | RPMAGTASK1-03 | Closed |
| Magnet RP Scope FDR 1 | RPMAGTASK1-04 | Closed |
| Magnet RP Scope FDR 2 | RPMAGTASK2-01 | Closed |
| Magnet RP Scope FDR 2 | RPMAGTASK2-02 | Closed |
| Magnet RP Scope FDR 2 | RPMAGTASK2-03 | Closed |
| Magnet RP Scope FDR 2 | RPMAGTASK2-04 | Closed |
| Magnet RP Scope FDR 3 | PRMAGSCOPEFDRIII01 | Closed |
| Magnet RP Scope FDR 3 | PRMAGSCOPEFDRIII02 | Closed |
| Magnet RP Scope FDR 3 | PRMAGSCOPEFDRIII03 | Closed |
| Magnet RP Scope FDR 3 | PRMAGSCOPEFDRIII04 | Closed |
| Magnet RP Scope FDR 3 | PRMAGSCOPEFDRIII05 | Closed |

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1. **FDR CHITs**

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| **Review** | **ID** | **Chit** |
| Magnet RP Scope FDR 1 | RPMAGTASK1-01 | Consider issuing a drawing ECN to the TF Bundle water fitting drawing to resolve the parker/swagelock disparity in lieu of a visual inspection (which requires kapton removal). |

Closed: Concur, a note will be added to the new TF Bundle drawing noting parker/swagelock fittings are nearly identical. No need to do visual inspection for part

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| **Review** | **ID** | **Chit** |
| Magnet RP Scope FDR 3 | PRMAGSCOPEFDRIII02 | NSTXU\_1-1-3-3-2\_CALC\_100 is pending review in DMS. However, the signatories on DMS don't match those on the PDF uploaded to the FDR II dashboard. Furthermore, the draft uploaded in DMS is altogether missing the calc and checker forms which appear in the PDF. Please ensure that the DMS upload includes all pages (calc & checking) and has the appropriate signatories. Please ensure that it then gets fully signed in DMS. |
| Magnet RP Scope FDR 3 | PRMAGSCOPEFDRIII03 | NSTXU-CALC-133-20-00 is a legacy calculation but the link in the NSTXU Documents Index is broken. Calculation is not retrievable. Please work with Kathleen to ensure that, at a minimum, the link is restored (pending a mass migration of legacy documents into DMS). |
| Magnet RP Scope FDR 1 | RPMAGTASK1-04 | NSTXU\_1-1-3-3-2\_CALC\_100 has been properly signed via PDF signatures. There is a pending DMS entry for it, but the review/approval personnel that were defined in DMS don't match those that signed the PDF. Work with Kathleen to ensure consistency when this CALC gets uploaded to DMS. |

Closed: CALC properly uploaded and approved in DMS on 2/28/2020

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| **Review** | **ID** | **Chit** |
| Magnet RP Scope FDR 2 | RPMAGTASK2-01 | Please review your resolution to chit \*PDR09 and PDR12...can't use budget justifications for these. Explain how Yuhu's calculation and the existing instrumentation configuration show the machine is properly protected.  For Yuhu's calculation and 09, I believe the answer is that the allowed tolerance on flow is generous, and so small variations in flow are not important.  For 12, the P&ID 5GA522 needs to be examined to resolve the issue. |

Closed: Readdressed the previous CHITs PDR09 and PDR12. PDR09: NSTXU\_1-1-3\_CALC\_101 shows that the flow tolerance is great, and small variations are inconsequential PDR12: Drawing 5GA522 Sheet 19 details PF5 instrumented with two supply valves and one return, which accommodates for either supply

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| **Review** | **ID** | **Chit** |
| Magnet RP Scope FDR 2 | RPMAGTASK2-04 | The posted DRP is not numbered and not signed. DRP needs to be properly finalized in DMS. Since this is a different scope from FDR1, please ensure you don't overwrite the FDR1 DRP. Need an DRP for each, I suppose, since they're separate scopes. |
| Magnet RP Scope FDR 3 | PRMAGSCOPEFDRIII04 | The DRP posted on the dashboard requires the document # and rev fields populated on the front page. It must then be uploaded and fully signed in DMS. |
| Magnet RP Scope FDR 1 | RPMAGTASK1-02 | The Design Review Plan needs to be finalized & signed (if available, consider populating the CRR number and including CALC\_100. |

Closed: DRP signed 2/25

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| **Review** | **ID** | **Chit** |
| Magnet RP Scope FDR 2 | RPMAGTASK2-03 | I am concerned that the strategy that has been developed, while correct for plasma/coil operations, is not correct for the bakeout configuration. This is a requirements problem first, then an issue with design (but is luckily only a SW issue). Please work with Gerhardt/Cropper/Petrella to sort this out. |

Closed: Auxillary Requirements document has been updated with the proper language to capture the full design. The DC supplies have flow switches that are read by the Bakeout PLC, and Cooling provisions for the TF coil shall be identical to that during normal operations.

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| **Review** | **ID** | **Chit** |
| Magnet RP Scope FDR 3 | PRMAGSCOPEFDRIII01 | NSTXU\_1-1-3-3-1\_CRR\_101 must be fully signed and posted in DMS |
| Magnet RP Scope FDR 2 | RPMAGTASK2-02 | CRR has been signed in PDF, but is called CRR\_XXX. Please obtain a valid DMS number and file in DMS. Thank you. |
| Magnet RP Scope FDR 1 | RPMAGTASK1-03 | Chits from previous review need to be officially closed. This means we need to finalize (sign/file) the Chit Resolution Report. |

Closed: Uploaded to DMS on 2/27/2020

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| **Review** | **ID** | **Chit** |
| Magnet RP Scope FDR 3 | PRMAGSCOPEFDRIII05 | Please make a measurement of the resistivity of the "grout" material. |

Closed: Resistivity will be measured and noted in report

# Cooling Fitting Upgrade

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| **Review** | **ID** | **Chit** |
| Magnets DVVR | MTF04 | Perform the cooling fitting upgrade/retrofit to the fittings in the upper bulkhead |
| Magnets DVVR | MTF34 | Lack of hardware verification during the assembly of coil cooling systems |

Closed: CHIT RPMAGTASK1-01 Rejects these CHITs as unnecessary as Swagelok and Parker have nearly identical specs. Testing will still be done on the fittings following ENG-014

# TFOL Cooling Tubes

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| **Review** | **ID** | **Chit** |
| Magnets DVVR | MTF06 | The cooling tubes on the new TFOL were damaged  during manufacturing. They were repaired, but it is unclear that they are reliable enough to last the full NSTX-U shot cycle |
| Magnets DVVR | MTF13 | Cooling tubes on several of the inner legs were twisted/distorted during removal from VPI mold.  They passed all pressure and flow tests and have been strain relieved, however care must be taken when working neat or with thses components |
| Magnets DVVR | MTF36 | The TF water tubes extend top and bottom and are vulnerable to damage. While care is used in handling, some small dings and detentes appear. These tubes are difficult to mend, require protection if possible, and need delicate care during maintenance evolutions to avoid water leaks and thus preserve the life of the Centerstack. |

Closed: -Hydrostatic tests were performed after after fabrication to 1.5x

operating levels. We will perform this test again

-Hydrostatic tests are performed again after re-assembly of connecting

hoses to 1.5x operating levels.

-Tubes are physically protected in-place by barriers.

-Tubes are inaccessible from outside the machine once assembled.

# Cap Block Rings

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| **Review** | **ID** | **Chit** |
| Magnets DVVR | MTF22 | Examine the spacing and material of the Cap Block rings (top and bottom) and cooling tubes.  "Top Cap Block Ring" and "Bulk Head Block Inner Ring |

Closed: No Stainless Steel materials located near energized parts. No action needed other than to update the drawing.

1. **G-10 plate**

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| **Review** | **ID** | **Chit** |
| Magnets DVVR | MTF39 | Thermal stresses between thick G-10 plate and cooling tubes at the top/bottom of TF cool. |

Closed: Cooling tube thermal expansion accommodated by nitrile washer between bulkhead bracket and G-10 bulkhead. Also addressed by simple hand calculation at a separate review by Steve R. explaining the G10 washers provide more than adequate relief for thermal growth

# OH Ground Plane

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| **Review** | **ID** | **Chit** |
| Magnets DVVR | MOH03 | Resistivity of the OH ground plane does not meet original requirement.  Re-apply to proper specification |

Closed: Perform OH Ground Plane Test Procedure to apply paint and measure the resistivity to ensure limits are within range.

# OH Ground Plane Strap

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| **Review** | **ID** | **Chit** |
| Magnets DVVR | MH05 | Consider re-design of OH ground plane strap to eliminate reliance on a single break, and improve attachment scheme. Introduce a second break, or otherwise reduce chance of toroReviewal short. Reduce reliance on G-10 piece to hold in place, if G-10 breaks then strap will fall off. |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR04 | Confirm adequacy of upper ground plane electrical connection (the intent of the chit MOH5) |

Closed: MH05: A review of supporting calculations indicate the forces on the plate are small. The G-10 used is used as an electrical isolation spacer, and not a mounting bracket. The existing design is simple and robust and does not require change.

Calculation NSTXU\_1\_1\_3\_3\_2\_CALC\_100\_OH\_Ground\_Plane has been filed and satisfies this CHIT

# TF/OH Grounding

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| **Review** | **ID** | **Chit** |
| Magnets DVVR | TFOH02 | The wires in the TF-OH gap were grounded for the first run campaign. Recent calculations show that the electric field can be reduced by floating the wires. This should be assessed in light of larger grounding consideration. |

Closed: The wires will be isolated from centerstack structural materials and brought to a termination block that is serviceable from the exterior of the machine. This will allow for floating, grounding, the addition of resistors, and the ability to test each wire in-situ.

# Ground Plane Resistivity

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| **Review** | **ID** | **Chit** |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR02 | Please assess the documentation of the ground plane resistivity; calculation should be filed at minimum. |

Closed: Calculation NSTXU\_1\_1\_3\_3\_2\_CALC\_100\_OH\_Ground\_Plane has been filed to detail ground plane resistivity requirements.

# Ground Plane Power Dissipation

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| **Review** | **ID** | **Chit** |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR03 | Confirm that minimum tolerance value of ground plane paint resistivity does not lead to excessive power/energy dissipation in the paint |

Closed: The voltage on the ground plane decays rapidly, from 600V to 50V in less than 30 milliseconds; therefore, the power dissipation is not a concern. See NSTXU\_1\_1\_3\_3\_2\_CALC\_100\_OH\_Ground\_Plane

# Aquapour

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| **Review** | **ID** | **Chit** |
| Magnets DVVR | TFOH03 | Wire stuck in Aquapour should be left floating, rather than tied to CS casing. This will minimize E-field perturbation and avoid bringing 2kV into the gap during CHI. Ends of wire should be insulated but accessible for periodic insulation resistance measurement |

Closed: Same as TFOH02. The wires will be isolated from centerstack structural materials and brought to a termination block that is serviceable from the exterior of the machine. This will allow for floating, grounding, the addition of resistors, and the ability to test each wire in-situ.

# OH Shims

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| **Review** | **ID** | **Chit** |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR01 | While this chit is out-of-scope for this PDR, the inspection of Aquapour wires evidenced as-built shims placed in-between the OH coil and its base. It is unclear if this as-built condition is a concern. It is recommended that the analysis group investigates whether motion between the OH and TF could cause issue with the visible interference with these shims and/or if the uneven bearing that the shims impose on the OH is problem. |

Closed: This issue has been addressed in the G10 ring peer review and detailed calculation has been filed (NSTXU\_1-1-3-3\_CALC\_104. Additional prototype testing was conducted, and a grout filler will be added to distribute the loads more uniformly.

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| **Review** | **ID** | **Chit** |
| MCS LOWER G10 RING RESOLUTION Peer Review | MCSLOW10RRESPR02 | Consider if a “belly band” solution for keeping the shims in place will increase the risk of tracking across the tops of the TF Flags and take appropriate measures to minimize |

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Closed: Installation Procedure will be utilized to cover the TF faces, flash-shield slots, and any areas the epoxy may contaminate

# Humidity

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| **Review** | **ID** | **Chit** |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR05 | The NTC humidity and therefore dew point is a significant risk to the machine beyond the Facilities responsibility to proves it. Evaluate dew point control requirements, define interfaces for hardware, responsibilities, and operations, revise operating procedures, ensure adequacy of interlocks, and considers RAMI. |

Closed: The facilities are updating the HVAC system to address the cooling and particularly the humidity/dew point. The requirements of ~35% dew point have been included in the facilities scope for the test cell. In the mean-time, humidity and dew point remain a factor in conducting daily hi-pot tests.

# Parker and Swagelok

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| **Review** | **ID** | **Chit** |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR07 | The Parker and Swagelok are each designed for ~4000psig. The as-built configuration (Parker nut/Swagelok body) should be pressure tested on bench to verify adequate margin. |

Closed: All fittings will be tested according to ENG-014 Hydrostatic Test

# Megger/Hipot

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| **Review** | **ID** | **Chit** |
| TF/OH Bundle Reliability PDR | TFOHBUNRELPDR08 | Do a megger/hipot before FDR, but have an HV SME involved in the procedure and execution in order to assess the unusual configuration. |

Closed: A Megger Test schedule has been established. Every 6 months the test will be performed. Data is recorded and logged.

# Preload Bolt Tension

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| **Review** | **ID** | **Chit** |
| Magnets DVVR | MTF30 | It sounded as a concern that if the preload bolts tension between the G-10 ring and SS flange is reduced, there is a concern that the slippage and twisting may develop at the flange-G10 interface. Install some positive means, like shear keys to prevent it and reduce the risk of motion |

Closed: The preload tension on the bolts is significantly less that the allowable to the tension. Jiarong’s calculation shows loads of 600-1000 lbf.

1. Grout the Type-1 bolts to register the skirt interfaces to provide positive restraints at the skirt interfaces.
2. Rely on the aquapour & friction, to provide restraint at the G10/TF interface.

# Cooling Water Interlock

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| **Review** | **ID** | **Chit** |
| Cooling Water System Interlock PDR | CWSINTPDR01 | The PLC software should annunciate which flow switch caused the system to trip - so we know which FS or flow path was the cause. Consider displaying this at PLC HMI and EPICS. |

Closed: There are currently individual flow switch alarms that will be displayed at the local PLC HMI

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| **Review** | **ID** | **Chit** |
| Cooling Water System Interlock PDR | CWSINTPDR02 | Revise the existing requirements document to specify if loss of flow in ANY cooling path shall shut the supply pumps down OR if only loss of flow on the TF & OH shall shut the supply pumps down. It is our current interpretation that any loss of flow event should shut the supply pumps down to minimize water leaks & potential damage from them, however the requirement document does not explicitly include paths other that the TF & OH. |

Closed: Add the requirements to 3.1 c of Auxiliary Requirement Document

When loss of flow is detected on any TF, OH, PF, or other misc. switch monitored by the cooling system, the supply pumps shall be shut down, and supply/return valves shall be turned off

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| **Review** | **ID** | **Chit** |
| Cooling Water System Interlock PDR | CWSINTPDR03 | The delamination risk exists for the TF outer legs as well; if cooling is lost in one of the conductors of the outer legs, but the others are cooled, then thermal stresses to some extent will develop. The requirements should reflect this case, either by stating the specific case of the outer TF legs, or a more generic statement about "loss of cooling" cases in coils with "bonded conductors". |

Closed: By shutting the pumps and valves off to stop the water flowing, Yuhu has done a calc on the inner legs calc ref NSTXU\_1-1-3\_CALC\_101

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| **Review** | **ID** | **Chit** |
| Cooling Water System Interlock PDR | CWSINTPDR04 | Add a mode to the logic to allow testing of flow switches during the morning startup (prior to plasma operations and excluding plasma operations) without dropping pumps out. |

Closed: A test mode will be introduced to allow water to flow, and manually check each of the flow switches to ensure PLC reads correctly

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| **Review** | **ID** | **Chit** |
| Cooling Water System Interlock PDR | CWSINTPDR05 | Is the resolution of the flow switches good enough to protect against flow imbalances that would harm the coil. |

Closed: By shutting the pumps and valves off when a leak is detected by the flow switch, we will reduce the flow imbalance that will keep harm to the coil at the minimum

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| **Review** | **ID** | **Chit** |
| Cooling Water System Interlock PDR | CWSINTPDR06 | Consider adding PLC logic to stop pumps based on differential between water temperature of parallel cooling paths. |

Closed: Considered, but not needed, because proposed change will shut down pumps and supply/return valves when an issue with the cooling path is detected.

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| **Review** | **ID** | **Chit** |
| Cooling Water System Interlock PDR | CWSINTPDR07 | Need "bakeout" mode in Water System PLC to allow condition with flow in outer layer only during bakeout (desirable) without turning off pumps. |

Closed: There is no bakeout flow switch detection path for the Cooling Water System. The bakeout PLC monitors the flow level

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| **Review** | **ID** | **Chit** |
| Cooling Water System Interlock PDR | CWSINTPDR08 | Loss of flow triggers loss of permission for the next shot. Consider interrupting the current shot & de-energizing magnets ASAP. |

Closed: The loss of water will disable the permission for FCPC to arm the coil for the next shot. If a shot is started it will not be stopped.

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| **Review** | **ID** | **Chit** |
| Cooling Water System Interlock PDR | CWSINTPDR09 | A discussion about detecting a partially blocked flowpath, a blockage that is insufficient to trip the flowswitch , could be detected by looking at the temperatures. This is a secondary detection of the flowrate.  There has been talk of installing flowmeters. If that work is done that would be a more direct method for detecting flow problems.  Consider deferring the analysis and programming to detect partial blockages until nearing coil-cooling operations, and if flowmeters have been installed a cost savings will be realized.  There is no requirement for partial flow. |

Closed: NSTXU\_1-1-3\_CALC\_101 shows that the flow tolerance is great, and small variations are inconsequential

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| **Review** | **ID** | **Chit** |
| Cooling Water System Interlock PDR | CWSINTPDR10 | For the FDR, will need to consider the new Software QA guidelines, if they are released. This may mean an independent code review of the ladder logic, or, software module testing if possible. |

Closed: We are using the current approved Software Change Notice which follows the QA guidelines to update the software change.

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| **Review** | **ID** | **Chit** |
| Cooling Water System Interlock PDR | CWSINTPDR11 | TF ONLY is a mode of the OH preheater system. In this mode OH water is valved off. This mode should be accommodated in the flowswitch-checking logic.  This nuance is not in the requirements for this review. |

Closed: This will be part of the program change. During TF ONLY mode, only TF water flow switches are monitored

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| **Review** | **ID** | **Chit** |
| Cooling Water System Interlock PDR | CWSINTPDR012 | Consider adding individual flow switches in PF5Ua, PF5Ub, PF5La, PF5Lb, so that flow in individual a/b sub-coils can be detected and interlocked. |

Closed: Drawing 5GA522 Sheet 19 details PF5 instrumented with two supply valves and one return, which accommodates for either supply