PRINCETON PLASMA PHYSICS LABORATORY

ENG-033 - CRR - CHIT RESOLUTION REPORT

Chit Resolution Report for Integration

NSTXU_1_CRR_100

Work Planning #:
Effective Date: **01/10/2020**
Prepared By: **Stefan Gerhardt**

Approved By	Kathleen Lukazik, Preparer	01/10/2020 16:49:29 PM

Chit Resolution Report for *Integration*

NSTXU_1_CRR_100, R0

Prepared By: Stefan Gerhardt Digitally signed by Stefan Gerhardt Date: 2020.01.07 08:01:55 -05'00'

Stefan Gerhardt, Systems Engineering

Prepared By: Peter Dugan Digitally signed by Peter Dugan Date: 2020.01.07 08:31:55 -05'00'

Peter Dugan, Cognizant Engineer

Approved By: Yuhu Zhai Digitally signed by Yuhu Zhai Date: 2020.01.10 09:20:55 -05'00'

Y. Zhal, Project Engineer

Approved By: Robert Ellis Digitally signed by Robert Ellis Date: 2020.01.10 09:31:38 -05'00'

R. Ellis, Chief Engineer

Record of Changes

Rev.	Date	Description of Changes
0		Initial Release

Table of Contents

CR-*SEI*-01 - *Requirements*

Review	ID	Chit
Integrated Design DVVR	IDD01	GRD duty cycle needs re-definition: Tpulse/Trepetition ≤ 5/2400, and 5/1200 following the future upgrade to 1200 sec repetition period. Not applicable to non-linear phenomenon such as cooling wave propagation through the water-cooled coils are such that these proportionality ratios are not applicable.

This statement was removed from the Recovery GRD NSTX-U-RQMT-GRD-001.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDD12	The GRD states that there shall be "Four toroidally symmetric connection points..." (3.1.2.d). The actual design actually has only 3 such points. Not a big deal, but should be consistent.

The GRD no longer opines on the number of connection points for the bakeout/CHI bus. Rather, this is in VV&IH SRD (NSTX-U-RQMT-SRD-004, Rev. 3), see 3.3f, 3.3j, and 10.3.5a.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDR04	GRD typo: Toroidal field into the page (clockwise in the toroidal direction, viewed from above): should be counter-clockwise

The new Recovery GRD correctly states the direction of the baseline toroidal field in 4.1d (in the baseline case, the rod current points down, the toroidal field is clockwise when viewed from above, so that Bxgrad(B) is down).

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit

Integration PDR	INTPDR03	GRD requires logging of changes to SRDs, however there is no tracking prior to initial release. Recommend favoring RELEASES so that tracking can begin and scope can be more clearly defined/controlled.

The GRD states: “5i. SRDs must have a revision log, tracking all changes to the document.” Given that revisions and releases are basically the same, the project policy is basically what is suggested.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integration PDR	INTPDR17	Is there a general requirement described on access to the test cell during a controlled entry during a run day? This may impact how quickly systems can enter and exit a state safe for entry.

There is a general requirement on the need for layered protection systems, including an access control system; see Section 6.7.3.1 of the GRD Rev. 3. These are flowed down to detailed requirements in -SRD-12 *Operations and Safety Systems*, and then even more detail in -RD-024 *NSTX-U Personnel Safety System-Safety Instrumented Systems Requirements* and -RD-26 *NSTX-U Trapped Key System (TKS) Requirements*

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integration PDR	INTPDR10	Consider requirements that address runaway electron generation in low density discharges.

At some level, this chit makes sense. However, it is not part of the defined Recovery Project scope. It may be resonsidered at some point in the future during operations.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDP05	In the GRD and the admittedly few other documents that I have read so far, I have not seen any discussion of any requirement to upgrade the radial field amplifier (RFA) performance. Limiting elongation for a given amplifier power and overall feedback loop closing time is indeed higher at lower li, but it is lower at higher aspect ratio, where you are now going. What is expected, e.g. what modelling of giant ELM or giant sawteeth or system noise floor have you carried out to assess the RFA capability?

…phrase derived from JET and maybe other facilities, where it refers to the system that makes …anging radial field, with the intent of controlling the vertical position of the plasma on the instability timescale (toroidal current crossed radial field makes a vertical force). In NSTX-U, the equivalent systems are the power supplies for the PF-3 coils.

The various documentation, for instance the Magnet Systems SRD (NSTX-U-RQMT-SRD-002) and the Power Systems SRD (NSTX-U-RQMT-SRD-006) call for 2 kV capability for the PF-3 coils. With this capability, NSTX was shown to have the ability to operate at elongations exceeding κ=2.7, provided the internal inductance was maintained below l_i=0.55 and aspect ratios expected for Recovery (A=1.7) (see Section 9 of S.P. Gerhardt et al 2011 Nucl. Fusion **51** 073031: link).

The NSTX-U GRD calls for operation at elongation of 2.5 and aspect ratios of 1.65 (see Table 4.1.2-1). Therefore, we expect that vertical stability to be assured with the required PF-3 voltage, provided the plasma internal inductance can be maintained at the values similar to the historical values.

Note that the designed changes to the passive plate brackets will lower the aggregate resistance of that loop, and therefore we expect that the vertical stability characteristics of NSTX-U will be somewhat better now than in the past, with slightly more margin compared to what is documented above. Also, there are additional tricks the program could play in the future to increase this margin, for instance, by reducing the control latency or using the RWM coils for fast vertical control.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDR20	GRD 3.1.3.1.e states that ONLY the OH coil shall have the CHI voltage added to the PS voltage in the definition of E (in 2E+1). But in the DPSS and PDD, the CHI voltage is added to the PS voltage for the inner PFs in determining the high-pot requirement. These are inconsistent, but I think the DPSS and PDD are more likely correct.

The CHI program is eliminated, so this consideration no longer applies.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
PF1B Bipolar Circuit FDR	PF1BBICIRFDR01	There are discrepancies in the pulsed current requirement: Magnet SRD 400kA-turns/1.0s Inner PF FDR 20kA-20turns/1.0s PS SRD 21kA/0.95s PF1B design document 21kA/1.0s OK, the design target (441kA^2-s) exceeds the requirement (400kA^2-s) but……

		This pulse current requirements for PF1B should be brought into alignment. Other circuits should be checked for consistency.

The first two are identical, so I am unsure what the point of contention is. The difference between 0.95 seconds and the other documentation is the number of significant figures (0.95 s is the answer).

As for the 21 kA vs. 20 kA, the bus work numbers have a convention of rounding up to the next highest kA. Hence the difference.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Project PDR	PROJPDR01	There is a set of important enterprise-level requirements that should be highlighted and shown how they connect in to the project. It was odd to see RD-010 for Magnetic Permeability highlighted at a high requirements level but no mention of the general SDC or Vacuum Handbook, etc...We should clean this up for the Director's Review. More Importantly, how do we prove that these basic guidelines are followed. --> Side question...Can RD-010 just be part of one of these handbooks?

This chit refers to slide 7 of this presentation.

This is basically a comment on presentations. It has no technical resolution.

I do note that we changed the presentation for the CDE-2/3A IPR, and now show the SDC along with the other GRD “annex” documents. See Slide 11 at link.

As for “Can RD-010 just be part of one of these handbooks?”...Sure, it could be, but it isn’t. And changing it now would likely muck up a lot of project documentation.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDR02	Both NSTXU-CALC-11-03-01 & the Structural Design Criterion expect the GRD to declare the PFCs as "critical" or "non-critical". This because they are brittle material, and therefor have some special rules. I do not see this declaration anywhere.

This is resolved in 6.1.1.1.2c of the Recovery GRD Rev. 3, where tiles are defined as critical components.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDR15	Need to specify a poloidal width for the halo current entry or exit in the GRD.

The Project has decided to extract all specifics of halo and eddy current determination from the GRD. These statements regarding poloidal width now reside in great detail in the document NSTX-U-RD-003-02, Appendix 2, as well as statement 4f.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integration PDR	INTPDR16	More a requirements issue, than an integration issue, but consider the advantages of having an upper tier document identifying required codes. Lower level requirements documents would need to consider/address these upper level codes and standards,

We don't think it is practical to list all possible codes that could apply. As a PPPL project, all PPPL safety manual, radiation protection, and engineering standards implicitly apply. This covers many aspects of 10 CFR 851, 10 CFR 835, and pressure system design.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
TF OH/Casing Trial Fit FDR	TFOHCTFDR03	The laboratory lacks a referenceable standard that all agree on and can easily reference regarding seismic qualification requirements for temporary assemblies. This should be resolved at the laboratory-standard level.

Standard ES-MECH-019, released 10/12/18, addresses Seismic Design for the laboratory.

Therefore, this chit can be closed. (Rev. 0)

CR-*SEI*-02 - DPSS

Review	ID	Chit

Integrated Design DVVR	IDD05	DPSS calculation of ripple currents in Inner PF coils need to be modified to include passive structure effects and inclusion of external filter inductors for two reasons. First, the AC inductance < DC inductance (assumed in original DPSS calculation) due to passive structure effects. Second, physics spec is becoming more stringent (was 1%, now requesting 0.1%). Increase in inductance may be achieved by increasing coil turns in coils that will be rebuilt, and/or adding external filter inductors.

The official part of the DPSS, i.e. the part that is officially checked and posted, does not include any model for the ripple.

The hidden sheet "Inner_PF_Design" has the requested corrections, in particular in Rows 120 and 121. This spreadsheet can be found on the DPSS page (link), or uploaded to the DMS along with NSTX-U_1_CALC_100.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDP04	The design point spreadsheet includes extensive computations for the coil set, accounting for a variety of equilibria and specifying TF, OH and plasma waveforms. Has time-dependent modelling of plasma pulses (such as using TSC) been performed? If so, I have not yet found references to it. Such a model could include passive structures and provide essential guidance to assess their impact. Issues such as obtainable current ramp rates and flat top time could also be assessed through refinement of the model (as identified in other chits).

Note that this is a very early chit, from the 2nd DVVR. In the present Recovery Project context, there are a few key replies:

- In general, fully time dependent physics simulations of start-up, ramp-up, flat-top and ramp-down using multi-physics codes such as TSC or pTRANSP have not been done. Frankly, the author of this report is familiar with such physics modelling (see link), and is not confident that such time-dependent modelling would actually provide any value for the design.

- The design point spreadsheet now has the ability to generate time-dependent scenarios for the key currents {Plasma, Toroidal Field, Poloidal Field, OH}; these calculations include subtle effects like the corrections to the PF coil current due to the OH leakage flux. This spreadsheet can be found on the DPSS page (link), or uploaded to the DMS along with NSTX-U_1_CALC_100, and the scenarios can be accessed there.

- There are key design activities where time-dependent simulations are necessary, namely, for disruption simulations. Two key examples:
    - The enhancements of the coil vertical loads due to the VDE effects were developed by A. Brooks, and are incorporated in the DPSS.
    - Numerous time dependent time simulations of disruption halo and eddy current loads have been done; the clear example of reference is NSTXU-CALC-10-07-2, *Global Disruption Simulations and Lorentz Force Data for PPs, PF support Slings, Bellows, HTP*, by P. Titus.

The contents of the two final bullets are the approach that the Project has taken to this problem.

, this chit can be closed. (Rev. 0)

Review	ID	Chit
Project PDR	PROJPDR02	The Design Point Spreadsheet (DPSS) needs to be placed under configuration control. It is a critical requirements "document" that A-1 designs are based on.

This spreadsheet can be found on the DPSS page (link), or uploaded to the DMS along with NSTX-U_1_CALC_100.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Integrated Design DVVR	IDO09	All turn counts will have to be revisited considering that the effective number of turns is typically less than the number of turn spaces, depending on details of the coil winding. These changes may or may not require a revision in the current rating to achieve the physics requirement in terms of amp-turns (10% headroom and round-up feature of DPSS calculation may already cover the difference). They also will result in changes to the coil resistances and inductances as well as the force and moment influence matricies.

The Design Point Spreadsheet has been modified with the updated (final) geometry, including the turn counts, the conductor geometry, etc. The coil resistances were updated. The complete set of force-influence matrices has been corrected for turn counts. The inductance matrices have been updated for turn counts. The maximum currents for the inner-PF coils have been updated.

This spreadsheet can be found on the DPSS page (link), or uploaded to the DMS along with NSTX-U_1_CALC_100.

Therefore, this chit can be closed. (Rev. 0).

CR-*SEI*-03 – *RAMI/Systems Engineering*

Review	ID	Chit
Integration PDR	INTPDR15	A lot has been done in the name of reliability, but there is no formal numerical assessment of reliability. Going forward a formal reliability assessment or RAMI program would help prioritize investments in redundancy, spares, inspections, and maintenance.

The Project has, since inception, been focussed on achieving high reliability for the machine core. As such,

…t has adopted a new FMECA approach, as manifest in the Project FMECA Plan (located in DMS … available here). FMECAs associated with all reviews now track to this format; any FDRs done before the FMECA plan was introduced have been retroactively updated.

The reliability of the supporting infrastructure (FCPC, MG, NB, TVPS) is not explicitly within the project scope. A FMECA process is being applied to these systems, but no formal RAMI process is part of the stated Project scope.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Project PDR	PROJPDR08	Tractability spreadsheet for requirements should be managed by RE's. Template for this design requirements matrix (ITER term) could be provided by system engineering but filling out the table should be done by the responsible engineer and/or analyst.

The requirements traceability verification matrix has been developed by the systems engineer; here is a link. Following each FDR, requirements verification methods are updated by the systems engineer and cognizant engineer, and relevant documents are addressed and verified by the Cognizant individuals responsible for the requirements.

Therefore, this chit can be closed. (Rev. 0)

CR-*SEI*-04 - *Physics*

Review	ID	Chit
Polar Region Design Integration Peer Review	POLARPEER02	Review how other groups define the halo current requirements. Is the definition here consistent with what other groups are doing?

We reviewed documentation from JET, AUG, & C-Mod. The methods used at PPPL are similar, and in some cases more comprehensive, than what was done at those facilities. The NSTX-U Recovery requirements are provided in NSTX-U-RQMT-RD-003, now at Revision 2, and show details not only of the halo current magnitude, but also of the various entrance/exit points, and descriptions of how many of each scenario should be considered for design purposes.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDD17	It is undeniable that the full physics treatment of VDEs cannot be incorporated into engineering design thinking for plasma-facing components and their support structures, but the highly stylised approach used for NSTX-U appears to be very over-simplified compared to that adopted for MAST-U. Particular oddities include the assertion that halo current forces always act outwards (i.e. towards the vacuum vessel, away form the plasma) whereas in reality the (relatively small) fraction of halo current that goes around the top of the vessel in a downward VDE (and vice versa) acts inwards. Also of course any local reversals of the poloidal path of the halo current on its least-resistance way to the other halo attachment region produce local inwards forces. Meanwhile I am not sure if the NSTX-U halo current cases include ones with the attachment regions on opposite sides of the vessel (inboard and outboard), readily created by the real plasma and producing a long radial path of I-halo X B-toroidal.

This is an old chit, written before the new NSTX-U Recovery halo current requirements were written.

The NSTX-U Recovery requirements are provided in NSTX-U-RQMT-RD-003, now at Revision 2. These include a discussion of the reversed halo current effect noted in the chit, and also have numerous cases describing various examples of the radial separation between the entrance and exit points.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Magnets DVVR	TFOH05	Document that there are no scientifically useful cases that cannot be reached due to limitations of the OH coil (temperature differential with TF and upper temperature limit). This includes science cases that incorporate long duration (5 s) pulses.

This is not well posed. The constraints on the OH temperature are real, and there is nothing that can be done about them w/o redesigning and rebuilding the bundle. Therefore, the key requirement is to demonstrate that there are scientifically useful cases that can be achieved with the bundle in the as-build configuration. The new GRD shows that the 5 second, 2 MA operating point, which is the basis for the scientific program, is still possible with this constraint. Indeed, the complete GRD shot spectrum can be achieved, as shown in the DPSS archived in DMS and available for reference here.   Therefore, the mission is possible.

There may be, in the life of the machine, some scenario desired by a team member that is prevented by the coil temperature differential rules; that this is the case does not reduce the value of the facility for completing the physics mission set out in the Recovery PEP and GRD.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR043	PFC Requirements have been derived presently for axisymmetric heat fluxes. NSTX-U operations will have short term, but possibly persisting 3D heat fluxes from dedicated coils or error fields. Will these lead to more stringent requirements?

Heat flux peaking due to 3D effects are addressed in the document NSTX-U-DOC-101. The can be a 10-30ish percent effect on heat fluxes, for the kinds of coil displacements under consideration.

It is true that initial requirements were based on axisymmetric heat fluxes. These requirements have been iterated in subsequent revisions to the requirements document (NSTX-U-RQMT-SRD-003). The reduced requirements accommodate effects such as thermal ratcheting.

The design is near optimal given the material chosen. It is not likely that any better tile design exists in isotropic graphite. Note that the design for the high heat flux regions is temperature limited, not stress limited, so localized heat fluxes are likely to result in plasma pollution rather than tile fracture.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR001	Design requirements are being modified for both PF coils and PFC components. This is made possible by excluding certain combinations of kappa, delta for 5 s pulse length at full parameters. It would be helpful to produce a plot in a kappa-delta plane with allowable pulse length contours to better understand the loss in physics flexibility

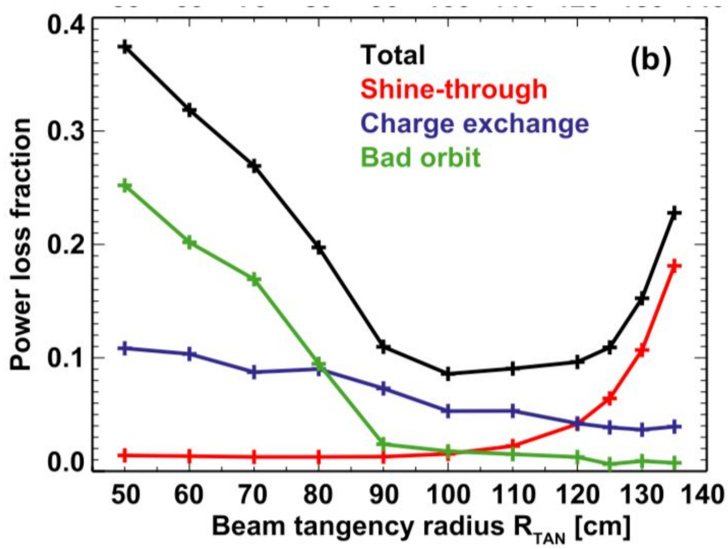
This chit is answered in the memo SEI-191214-SPG-01.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDP06	High R-Tan NBI, unless tilted to align with total magnetic field vector in region of dominant deposition (which I think also improves the current drive efficiency by reducing the trapped fast ion fraction) may cause excessive prompt orbit losses, not mentioned as a limiting factor for current drive optimisation. Was it found that new armour was needed to protect the outboard regions where these prompt-loss ions will go?

The orbit losses of the neutral beams have been computed many many times, using TRANSP and NUBEAM. It turns out that the orbit losses are far higher for the inboard beams (the legacy NB #1, with tangency radii of [50,60.70] cm), than the outboard beams (NB#2, with tangency radii of [110, 120, 130]

...ed, the orbit loss from the outboard beam is basically negligible. This can been seen most clearly ...23 of J.E. Menard et al 2012 Nucl. Fusion **52** 083015, reproduced below



What the outboard beam does potentially create is an increased load on the armor due to shine-through if the edge of the plasma is insufficiently dense. The neutral beam armor, however, is design to accommodate these shine-through losses as part of the Upgrade-era design. This is documented in the calculation NSTXU-CALC-11-05-00, *Thermal Analysis of Neutral Beam Armor Array*, available here.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDP1	Research results suggest that the Ip ramp down rate of 4MA/second may not be reliably achievable, such that an extra 0.5 seconds may required for ramp down, and 0.5 seconds less may be available for flat top.

The GRD has been adjusted to show a reduced ramp-down rate of 1 MA/s. See Figure 4.1.2-1:

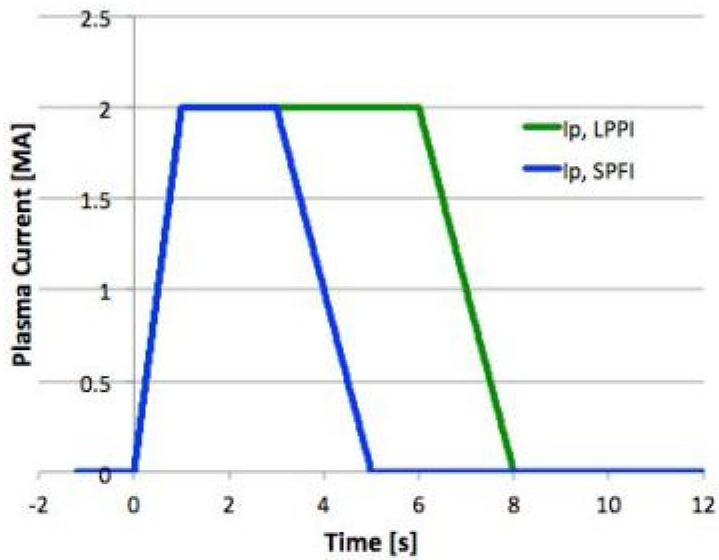


Figure 4.1.2-1 *- Reference 2 MA plasma current waveforms.*

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDP10	In DEMO advanced divertor design discussions, use of very high flux expansion (aka "flaring") is considered troublesome (above a factor of say 15-20 from outboard mid-plane to divertor target) due to small control errors in angle of divertor leg causing the strike point(s) to be at too steep an angle or even to miss the intended strike location completely. For NSTX-U, has the accuracy of strike point angle and location been addressed with realistic noise, sawteeth, ELMs etc.?

This is a very old chit, created before the new PFC design had even been initiated. The PFC SRD that supported the PFC FDR had requirements over a range of angles from 1° to 5°. It is acknowledged that if a control error leads to a field line angle above this range, some leading edges may be seen. If it is below this range, the heat flux peaking factors will grow very larger. Some studies have been done by the PFC working group to understand the range of control, but this is a topic that will extend into the operations phase.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDR05	Recent refinements in the physics understanding and modeling of scrape-off layer width suggests that the power flux width at the divertor will be smaller than assumed when the GRD requirements were developed such that the peak heat flux may be higher than

		indicated in the above table. In addition, a column needs to be added to cover equilibria cases where the outer strike point is on the outboard divertor instead of IBDH.

The heat fluxes in the PFC SRD (NSTX-U-RQMT-SRD-003) were initially derive from the new models that are noted in the chit. See the memos that supported the Rev. 0 release of that document. It became clear during design iteration, however, that the very large heat fluxes predicted by a simple us of this model would could not be accepted by any tile design known to man. Therefore, the requirements were iterated to find an appropriate compromise between physics performance and engineering limits. This resulted in the optimized design at the time of the FDR.

Note that there are cases in that SRD with the outer strikepoint on the outer target, as suggested by the chit.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDR08	Revisit vertical target heat flux requirements in light of new calculations

The vertical target heat fluxes were totally revised, using new models for the SOL width and the in-out power split; see the PFC SRD (NSTX-U-RQMT-SRD-003) and design basis memos cited there for additional information.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDR09	Must ensure that the proper horizontal target heat flux peaking is used, as per the more recent calculations...more like 5-10 cm instead of 30 cm

The horizontal target heat flux peaking was revisited for the Recovery design. This includes cases with some peaking, but also cases that are basically uniform in heat flux over that area due to the use of very high flux expansion or sweeping. See the PFC SRD (NSTX-U-RQMT-SRD-003) and design basis memos cited there for additional information.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDR14	Should clearly state that the TPF = 2 number is applicable to the locations where the current enters or exits the structure.

This is addressed in 4e of the Disruptions RD (NSTX-U-RQMT-RD-003, Rev. 2), where the distinction between the “tile normal currents” and the structure currents is drawn in an extended discussion.

, this chit can be closed. (Rev. 0)

Review	ID	Chit
Magnets DVVR	MTF01	Need to analyze consequences of misalignment of central TF bundle and OH solenoid w.r.t. outer PF coils and PFCs. Then need to assess priority for fixing this during current outage or developing ways to live with it.

There is a Project KPP related to magnet alignment (see PEP, as well as the memo SEI-190712-SPG-02 which explains the physics basis for the KPP)

There is a Project requirements document (NSTX-U-RQMT-RD-011).

These two documents define the required level of alignment that the sponsor is willing to live with (the KPP) and that the Project desires to achieve (the requirements document). These are then further refined in the calculation NSTXU_1-1-2-3-2_CALC_100, which provides a Monte-Carlo analysis of how the requirements in -RD-11 will be met.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Vacuum Vessel & Internal Hardware DVVR	VVIHPFC19	Centerstack heat flux GRD has no lamda_q specified. Update based on realistic limited plasma scenario, ensure these limits are known by CoE/PO.

For the Recovery design activities, the requirements for the centerstack heat flux are clearly given in NSTX-U-RQMT-RD-013, and are based on a range of physically meaningful scenarios.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Vacuum Vessel & Internal Hardware DVVR	VVIHPFC20	[This issues has probably already been flagged] The heat flux loading specs apparently assume a 1 degree field line attack angle. This translates into a requirement spec for tile alignment or the need to implement ‘ramps’ in tile edges to eliminate leading edge effects – something that needs to be addressed.

The Recovery tiles in the high heat flux regions are ramped, as suggested by the chit, and exactly for the reasons indicated in the chit.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Vacuum Vessel & Internal Hardware DVVR	VVIHPFC24	Define halo current direction and engineer to prevent current paths that create forces away from wall

The halo current directions are defined in detail in Section 4 of NSTX-U-RQMT-RD-003-02. Designs do consider the halo current paths, with the intent of not allowing force directions outside the design basis. As an example, please see NSTXU-CALC-011-18 *PFCs Analysis of the IBDH Tiles* as an example.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Realtme Control & Protection DVVR	RCPDCPS15	Is there a margin in force/current limits to account for asymmetry in post-disruption currents since both assumed shapes are symmetric?

At the time of the RC&P DVVR, the answer to this was unclear.

Since then, the effects of VDEs have become much better defined. Simulations were done of the drifting plasma and the induced currents, all of which contribute to the vertical load on the coils (and therefore structures). These are included in the vertical load calculations captured in the Design Point Spreadsheet, which is archived in DMS; see the associated calculation NSTXU_1_CALC_100, *Design Point Calculations for NSTX-U*. These loads were used in design.

The DCPS force limits will be configured to NOT account for the VDE effect, and will therefore be somewhat less than the stated values in the calculations. The difference between the DCS limits and the calculation limits is the margin requested for these up-down asymmetric effects.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Realtme Control & Protection DVVR	RCPDCPS16	Can differences in L/R time lead to transient increases in forces after suppress and bypass and if so is this accounted for in limits?

This was addressed in the calculation NSTXU-1-1_CALC_100, *Calculation for the NSTX-U (fz) Transient Forces*, by C. Bovet.

The answer is NO, the forces do not increase after a suppress and bypass.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Realtme Control & Protection DVVR	RCPDCPS33	At least in the case of coils coupled to vertical motion, I'm surprised that the current extrema experienced in NSTX/NSTX-U have been set by equilibrium current levels rather than VDE-induced currents. It may have been true due to the very high stability margin in operations to date, but increases in the elongation target planned for NSTX-U may imply that this will change in the future. The potential for increased VDE-induced currents should be evaluated and if significant, may need to be incorporated in DCPS parameters. At sufficiently low stability margin, this source of additional coil current can be quite different from current to simply produce vertically-shifted equilibria. (Implications for calculation are related to Dan Boyer's previous chits)

At the time of the DVVR, the increase in the coil vertical loads due to VDE effects had not been clear. However, during the preparation of the load cases for the Recovery project design, the so-called "VDE load" was clarified. Simulations were done of the drifting plasma and the induced currents, all of which contribute to the vertical load on the coils (and therefore structures). These are included in the vertical load calculations captured in the Design Point Spreadsheet, which is archived in DMS; see the associated calculation NSTXU_1_CALC_100, *Design Point Calculations for NSTX-U*

The structures were designed for the VDE loads. Therefore, providing that the plasma and coil currents are bound to be acceptable in the equilibrium flat-top condition (bounded by DCPS…), we can be assured that they will be in-bounds for the VDE loads.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR037	For PDR, we should have a good explanation for how we handle the 30% of power that is not directed to the vertical or horizontal targets. This power goes to large radius (plates, OBDs, vessel). Can it just be rejected to the air, or do we need to cool via gas or water?

The power handling is clearly defined in the calculation NSTXU-CALC-10-6-01, NSTXU Recovery Global Heat Balance Calculations, which is in turn based on the requirements in NSTX-U-RQMT-RD-013 Thermal Scenarios. That requirrements document describes a number of operations thermal scenarios.. The calculation shows that…

Thermal Scenario 2: HTP cooling removes 42.2% heat, HTT 15.4%, O ring cooling 0.5, radiation to envir 2.6%, conv to envir 4.0%, PFCs absorb 11.1% and structures absorb 25.1%

Thermal Scenario 3: HTP cooling removes 1.5% heat, HTT 15.9%, O ring cooling 1.4, radiation to envir 6.6%, conv to envir 8.6%, PFCs absorb 17.9% and structures absorb 53.4%

Thermal Scenario 4: HTP cooling removes 2.6% heat, HTT 8.3%, O ring cooling 0.6, radiation to envir 7.6%, conv to envir 10.0%, PFCs absorb 15.8% and structures absorb 58.2%

l add up to a little higher than 100%, because there is also some heat from OH and PF (OH 100 C, PF1a 60 C, PF1b 100 C and PF1c 60C) and cannot totally removed by their cooling.

Review	**ID**	**Chit**
NSTX-U Recovery Project - CDR	RPCDR042	Geoff Fishpool (and doubtless others) was basing HC force and torque analyses in MAST-U on a linearly ramped variation of halo current density with minor radius through the HC halo, which of course becomes a variation of HC density with poloidal angle along the surfaces of the PFCs (and also a variation with toroidal angle following the usual TPF model). Such an assumption is generally going to be worse for some tiles than that of a constant halo current density across the HC contact patch.

This appears to be more of an informative comment than anything else. The NSTX-U assumption on halo current is provided in NSTX-U-RQMT-RD-003, where the poloidal width is clearly specified. Further, in the appendix, a number of scenarios are provided showing currents entering and exiting various structures.

Therefore, this chit can be closed. (Rev. 0)

Review	**ID**	**Chit**
Integration PDR	INTPDR04	Thermal RD L-mode Scenario 5: Conceivable that more than 3MW could be injected into this shape, especially as Bt, density (Ip) increases. These shots may enter H-mode (either on purpose or inadvertently).

Scenario #5 puts power on the CSAS tiles and the OBDR4 tiles. L-mode plasmas basically always put power in these regions, and it is difficult (impossible?) for an L-mode scenario to put power at any other location (this is because the high internal inductance of those plasmas results in their having relatively low elongation and high divertor coil currents; this in turn results in the flux lines that link the plasmas and coils striking the divertor on the CSAS and far OBD).

The project basically committed to having these tiles be “low heat flux”, which limits the heat fluxes to basically the levels indicated in the thermal scenarios RD. It is true that these plasmas could go into H-mode; doing that alone will tend to move the strikepoints toward the high heat flux tiles.

It is also true than an H-mode plasma with more than 3 MW of heating power could be created that would place heat on the CSAS and far-OBD. However, this would be in conflict with the “low-heat flux” region dicasstate, and is therefore not a use case driving engineering.

For all these reasons, this chit can be closed. (Rev. 0)

Review	**ID**	**Chit**

Integration PDR	INTPDR05	Thermal requirements RD: No long-pulse at reduced Bt is specified (8 - 10s at Bt = 0.75T, PNBI = 6 MW)

This is a correct observation. The 8-10 second pulse scenarios are interesting, but they are not part of the design/requirements basis. If the scientific value they provide is worth the difficulty (FCPC protection system modifications…) then the program may request such scenarios, at some point in the future after operations resume.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integration PDR	INTPDR14	SG mentioned "JET has significant poloidal currents during TF ramping but NSTX-U does not", I think in the context of my chit about starting the plasma during the TF ramp-up with its caveat about the poloidal field pick-up coils. But I did not mean the signals generated by poloidal currents in the vessel so much as the orientation of the pick-up coils: a few degrees makes the coil see a larger signal from the B-phi-dot than from the B-theta-dot. Active compensation may be needed, offsetting the B-phi-dot pick-up from the coil signals.

It is possible that such compensation will be needed. There are a large number of static and transient compensations applied to various NSTX-U magnetic sensors, and an additional compensation of the type noted here would not be difficult to implement, either transiently or in realtime. Indeed, such compensation already exists for the RWM sensors.

In any case, the need for such compensation can only be determined once the machine is operating.

Therefore, this chit can be closed. (Rev. 0)

CR-*SEI*-05 - *Bakeout*

Review	ID	Chit
Integrated Design DVVR	IDD08	A variety of issues have arisen with respect to bakeout that have prevented the achievement of required 350C temperature while maintaining PF1B coil insulation temperatures at allowable limits, and PF1B mandrel welds at allowable stress limits. These are under investigation but have not be fully resolved.

Numerous steps have been taken along the lines indicated by this very old chit:

- The PF-1b is no longer directly connected to the vessel flange. It is rather separated from the flange via a layer of microtherm.
- There is a dedicated “heat transfer plate” on the horizontal target, which can provide heating via hot He directly to the horizontal target tiles.

, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDO11	Does a corrosion issue arise if bake out tubing is used for water cooling between shots?

This has been the practice at NSTX-U for the life of the project. This issue is resolved by the use of extensive blow-down and drying cycles before He is introduced, and no corrosion has been observed. Note that this transition only occurs a small # of times in the lifetime of the facility (basically one a year).

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Vacuum Vessel & Internal Hardware DVVR	VVIHBI06	Based on the community's large operational experience with carbon PFCs in tokamaks, it is essential that the PFCs be bakeable to 350C. Otherwise the facility will spend too much of its valuable operational time doing 'wall conditioning' (plasma assisted or otherwise).
Vacuum Vessel & Internal Hardware DVVR	VVIHBI07	Standard practice with carbon divertors is to assure 350 deg C bakeout. This is consistent with reaching the temperature at which water production peaks. It should be robustly incorporated into the design.

The requirement in the Recovery GRD and related documents is to achieve a 300 ℃ bakeout for all graphite-based materials in NSTX-U. This is 40 ℃ in excess of the Project KPP. The detailed rationale for these numbers is provided in the memo SEI-190712-SPG-01.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDO13	Consider alternative methods to meet requirement that bakeout provides: e.g. (1) can the contaminants (water, etc.) be kept out of the chamber some way? or (2) can water be driven out a different way (e.g. intense UV light source inside the chamber)
Integrated Design DVVR	IDO14	Along the lines of S. Weidner's comment, could the ech system be used for localized cleaning of the tiles that don't reach the desired temperature during bakeout?

Alternative means of bakeout were briefly considered, but none were as conceptually functional as the legacy scheme.

Avoidance of contamination is a challenge, in that it implies the inside of the vessel would always be maintained in dry nitrogen or similar inert gas. This would require individuals entering the vessel were some sort of breathing apparatus, with many implications for worker safety and efficiency.

The UV light source would displace other instruments that use port space, and would need to operate at the level of many 10s of kW with high reliability.

ECH systems are challenging due to the need to run the toroidal field in DC, and would again require very high power levels to heat the bulk of the tiles. Note that an ECH scheme might work well as a substitute for GDC, but not as a surrogate for bakeout.

The legacy scheme has none of these disadvantages, and so was retained.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDO19	Use electrical heaters in tiles as designed and tested for c-mod advanced divertor?

This choice was briefly considered; the C-MOD advanced divertor has these features, as do the tiles on MAST-Upgrade. However, there were a number of factors that made this less attractive. There is limited space available to extract wires from the center column region of the device (via the organ pipes basically, and what space there is taken up by diagnostic wires), and PPPL had less than optimal experience with electric heaters for LLD. This could have been remedied, but only with more R&D. Furthermore, switching to electric heaters would have required a larger ex-vessel engineering effort to power them. For these reasons, the legacy combination of hot He and DC current was retained in the device.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDO20	PF1C is part of the vacuum boundary, it might leak, something to ameliorate needed.

In the new design, the PF-1c coils reside within a forged and machined housing. This housing is a robust component, unlike the legacy -1c can which used very small welds on the vacuum boundary. See the MCS FDR slides for more information on the design of this component (https://sites.google.com/pppl.gov/20190725-mcs-fdr/home)

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDR21	The requirement to bake the NB armor to 350C is never explicitly given. Indeed, the NB GRD (NSTX-RQMTS-GRD-108, Rev 0, April 1 2009) even gives the impression that a 150 C bake is

		acceptable. Thankfully, the engineers have understood the requirement abstractly and provided for the proper armor bake. The requirement should be made explicit. (http://nstx-upgrade.pppl.gov/Engineering/Overall_Project_Information/GRD/NBI_Rev0/NSTX_2nd_NB_GRD-R0.pdf)

The heating of the neutral beam armor is now required in statement 6.3.3.1b of the GRD.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Polar Region Design Integration Peer Review	POLARPEER15	AC OH baking. This option should not be discarded before analyses have been made featuring the use of other PF coils with the same or opposite phase current to improve the resulting distribution of heating in the vessel (etc.). Similar schemes have been used successfully in Compass, DIIID and MAST.

The use of the OH coil to inductively heat the vessel was addressed in the document NSTX-U-DOC-001-01. The cost-benefit analysis shown in that document indicates that retention of the DC current bakeout scheme and upper ceramic insulator is the desired path.

Note that Rev. 1 of that document, which incorporates comments from Tom Todd, occurred well after this chit was written 4/21/17 by that same individual.

Thus, the author of the chit implicitly concurs that this chit can be closed. (Rev. 0)

CR-*SEI*-06 – *PDD*

Review	ID	Chit
Integrated Design DVVR	IDD09	Table 13 of the PDD shows the midplane radial build. Consider doing a similar table, but for the radial build at the height corresponding to the mid-point of the PF-1a coil (I think upper and lower are identical in this context).

The PDD was written to assist in the DVVR process. The project posture as regards an update to the PDD is uncertain. Therefore, this chit remains open in Rev. 0 of this chit report.

Review	ID	Chit
Integrated Design DVVR	IDD11	As presently stated in the PDD, the impression is given that the OH water heater is there to provided an elevated initial OH temperature. While it can do this, the primary function is to mitigate the cooling

		wave. The PDD should be reflect this hierarchy of function.

The PDD was written to assist in the DVVR process. The project posture as regards an update to the PDD is uncertain. Therefore, this chit remains open in Rev. 0 of this chit report.

Review	ID	Chit
Integrated Design DVVR	IDR03	The OH high-pot is given as 17 kV in the PDD, based on 2*(6+2)+1, where 6 kV is the OH voltage and 2 kV is the CHI voltage. But the GRD Rev. 6 explicitly states that the sum of OH and CHI voltages shall not exceed 6 kV.

There is no CHI voltage requirement for the Recovery.

The PDD was written to assist in the DVVR process. The project posture as regards an update to the PDD is uncertain. Therefore, this chit remains open in Rev. 0 of this chit report.

Review	ID	Chit
Integrated Design DVVR	IDP03	Halo current analysis as outlined in NSTX-U_PDD provides appropriate initial guidance for design of vacuum vessel and internal components. However, the magnitude and distribution of the halo current assumed is based on empirical results. These may change (for better or worse) as the device pushes into new operational regimes. The project (and the the physics community) would benefit if halo current magnitudes and distributions could be measured at key locations, directly determining component loading and margin to failure.

The project includes shunt tiles on the lower outboard divertor and CSFW, intended to measure halo currents. There are also the array of “tilted Mirnov” sensors on the CSFW midplane and the halo current rogowski sensors on the IBDV. Finally, we intend to measure the currents in the lower CHI bus.

These may be expanded in the future, but these are the sensors that will be present when the Recovery outage is over.

This chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDR19	On page 36 of the PDD, there is a table without any Table Number. More critically, this table has the same issue as Table 15 in suggesting that the OH shall be subjected to 6+2 = 8 kV, instead of the GRD clamp at 6 kV.

The PDD was written to assist in the DVVR process. The project posture as regards an update to the PDD is uncertain. Therefore, this chit remains open in Rev. 0 of this chit report.

Review	ID	Chit
Integrated Design DVVR	IDR07	Table 2 of the PDD mentions the CS upgrade requirements document (NSTX_CSU-RQMTS-GRD-R6). It should also mention the other operative requirements documents, including at least the NB upgrade requirements document (NSTX_2nd_NB_GRD-R0), and maybe also the PFC requirements document (http://nstx-upgrade.pppl.gov/Engineering/Overall_Project_Information/Requirements/NSTX-U-SRD-11%20rev0.pdf)

The PDD was written to assist in the DVVR process. The project posture as regards an update to the PDD is uncertain. Therefore, this chit remains open in Rev. 0 of this chit report.

Review	ID	Chit
Integrated Design DVVR	IDD13	3.1.3.2.e states that the TF lead shall use a coaxial design. This seems like a copy-paste error from the OH? In any case, the TF leads are not coaxial (nor should they be I would guess)

The PDD was written to assist in the DVVR process. The project posture as regards an update to the PDD is uncertain. Therefore, this chit remains open in Rev. 0 of this chit report.

CR-*SEI*-07 – *Centerstack Casing/Alignment/MCS*

Review	ID	Chit
Integrated Design DVVR	IDD20	Do you consider the center stack casing a good reference surface? If so, you should simply shim the oh/tf relative to it. We have found that more complicated systems of alignment often offer no real improvement. You should continue simulation work to determine how sensitive you really are to alignment errors.

Our understanding of alignment requirements has progressed considerably since the Integrated Design DVVR in January of 2017. The present alignment strategy does indeed call for the OH/TF bundle to be aligned to the casing, via a shimming step at the outer skirt interface. Hence, we have adopted this recommendation. We additionally intend to align the TF bundle to the main vessel nozzles, thereby ensuring that the OH/TF bundle is centered in the machine proper.

Note that all of the sensitivty to error fields is studied heavily in NSTX-U-DOC-101, and more then discussed in great detail in NSTXU_1-1-2-3-2_CALC_100. See the detailed discussion there.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Polar Region Design Integration Peer Review	POLARPEER27 POLARPEER36 POLARPEER37	What are the implications of the alignment of the center stack wrt to the TF on the heat flux to the tiles? More broadly consider tolerances with respect to the magnetic fields on the heat fluxes to the components.

The implications of various tilts and shifts on tile heat fluxes are shown explicitly in the document NSTX-U-DOC-101-00. See in particular Table 2.1.7-1.

In general, concerns related to coil alignments impacting heat fluxes are discussed in that document, and these became the alignment requirements in NSTX-U-RQMT-RD-11. The design features meeting those requirements are manifest in NSTXU_1-1-3-3_CALC-101 *Machine Core Structures: Alignment and Tolerance Stack-Up Assessment.*

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Project PDR	PROJPDR06	A few times today (Weds) we have heard that the tapered part of the centre tube might be done away with. This surely implies considerable impact on many of the design details of the adjacent components inside and outside the vacuum boundary in that region, top and bottom of the machine of course. Is this issue one of the risks already identified?

This chit was based on a simple misunderstanding, as indicated in this exchange:

PPPL

Stefan Gerhardt <sgerhard@pppl.gov>

your chit...
2 messages

Stefan Gerhardt <sgerhard@pppl.gov> Wed, Aug 15, 2018 at 3:43 PM
To: TNT <tomnoelt@gmail.com>
Cc: Valeria Riccardo <vriccard@pppl.gov>, "G. Loesser" <dloesser@pppl.gov>

Hey Tom:

"A few times today (Weds) we have heard that the tapered part of the centre tube might be done away with. This surely implies considerable impact on many of the design details of the adjacent components inside and outside the vacuum boundary in that region, top and bottom of the machine of course. Is this issue one of the risks already identified?"

We may have mis-communicated. In fact, I'm sure we did...

We are not planning to do away with the angled part of the casing! This would be a profound change, as you correctly identify.

Rather, we are discussing getting rid of the cooling tubes embedded on the air-side of the casing. Having the same tubes transition from the straight section to the angles section makes them challenging and time consuming to fabricate. Hence, the discussion of potentially eliminating the angled section of the cooling tubes.

Stefan

--
Stefan Gerhardt

Tom Todd <tomnoelt@gmail.com> Wed, Aug 15, 2018 at 5:03 PM
To: Stefan Gerhardt <sgerhard@pppl.gov>
Cc: Valeria Riccardo <vriccard@pppl.gov>, "G. Loesser" <dloesser@pppl.gov>

Ah-hah! That does make more sense! Sorry for the misunderstanding.

See you tomorrow!

TNT

[Quoted text hidden]

Therefore, this chit can be closed. (Rev. 0)

Review	**ID**	**Chit**
Polar Region Design Integration Peer Review	POLARPEER22	Is anyone looking at compatibility of the proposed polar region designs with the cryopump design?

Apart from cursory discussions, the CP design from 2015/2016 era is not driving any decisions. Formally, the Recovery requirements basis does not have any CP related statements, and so the engineers have no mandate to consider impacts on that design. Moreover, the new load specifications and understanding from the Recovery analysis means that much of the CP design would need to be repeated.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Vacuum Vessel & Internal Hardware DVVR	VVIHBI11	consider replacing IBDhs graphite tile with high-Z tiles which could meet bakeout spec at lower temperature

While it is true that replacing the IBDH tiles with high-Z materials would resolve the bakeout concerns in that region, it introduces many new concerns. In particular, the potential contamination of the plasma by high-Z impurities would need to be considered; the prospect for tile melting also exists. These would have complicated the initial run campaigns following the Recovery outage, putting at risk the ability to achieve the physics goals for those campaigns. As such, a programmatic choice was made to retain graphite PFCs, and this is the Project baseline design.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Vacuum Vessel & Internal Hardware DVVR	VVIHPFC12	100 kW/m^2 on the inner wall PFC could be exceeded by a high power, high radiation shot.

The radiated power distribution for 5 different scenarios is provided in the document NSTX-U-RQMT-013, in Table 2-3. This table provides all requirements for conducted and radiated powers, and includes a 100% radiated power scenario.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Polar Region Design Integration Peer Review	POLARPEER04	Snowflake divertors and monodirectional fish-scaled tiles on the IBD-H may not be compatible.

The concern underlying this chit is that the secondary strikepoints of a snowflake divertor will have reversed helicity. These strikepoints may land on the IBDH tiles, thereby directly illuminating the fishscale edges.

A modest requirement for reverse helicity heat flux handling is included in NSTX-U-RQMT-SRD-003. Designs presented at FDR meet the present requirements; see NSTXU-CALC-011-18 *PFCs Analysis of the IBDH Tiles*.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Polar Region Design Integration Peer Review	POLARPEER05	Requirements for PFC design should consider/address "achievable" assembly tolerance WRT to tile position, combined with alignment of PFC's WRT measured magnetic field.

The PFC design, and in particular the fishscale angles, are indeed based on detailed analysis of achievable assembly tolerances. See the calculations at the PFC FDR, and in particular, the following calculations:

- Fish Scale Directionality of OBD12 Tiles (NSTXU-CALC-11-22-00)
- Tile Shaping of IBDH High Heat Flux Tiles (NSTXU-CALC-11-31-00)
- Tile Shaping of IBDV Tiles (NSTXU-CALC-11-32-00)

Therefore, this chit can be closed. (Rev. 0)

CR-SEI-09 – HHFW

Review	ID	Chit
Integrated Design DVVR	IDO01	The operations requirement for the HHFW system is not presented. In principal it is desired to have HHFW provide electron heating during high power neutral beam operation to both add to the stored energy and to help expel heavy impurities from the core plasma. To accomplish this, arc protection will need to be maintained in the presence of large ELMs. Initially HHFW power will be blanked during ELMs but a matching system for ELMs should be added to the HHFW system to optimize routine HHFW operation and to assure arc protection in the presence of large ELMs.

Various schemes for arc protection have been considered, but implementing them is not a high project priority for the program, and is not part of the Recovery Project scope. One reason for this is that the core physics mission is designed to be competed with neutral beam heating alone. HHFW would no doubt assist in the confinement studies (reversed shear studies, for instance) and sustainment studies (raising T_e raises the non-inductive fraction). However, it is not essential.

Therefore, this chit can be closed (Rev. 0).

CR-SEI-10 – Inner PF

Review	ID	Chit

Vacuum Vessel & Internal Hardware DVVR	VVIHPF1CCB20	Protect PF1C from steady state and transient plasma loads

The new tile design has a "labyrinth" feature at the interface between the OBD R1/2 tiles and the IBDH tiles. This feature accommodates thermal expansion of the CS, while also protecting the PF-1c reentrant can.

Note also that although the prospect of direct heat flux on the PF-1c can is eliminated, that can is nonetheless dramatically more robust in the new design relative to that from the Upgrade-era.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Project PDR	PROJPDR03	Consider a feasibility assessment of adding correction coils at some future date

This chit is a reference to the polar region design. This design is complicated enough as is; additional scope cannot be added at present.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Project PDR	PROJPDR04	(I don't know what the categories A1-A3 mean, hence choosing A2!) It was said that PPPL does not intend to measure the magnetic centres of the PF coils and would rely on destructive examination of prototype coils to gauge the discrepancy between the insulation surface and the nominal conductor locus, performing only mechanical alignment. This begs the question of a) provisions for QA oversight of the production coils, e.g. turn transition locations, and b) whether or not the anticipated errors could be trimmed out by the error field correction coils on the outer surface of the vacuum vessel.

The tolerance stack for coils assumes a displacement of the windings relative to the coil ID; see Section 2.5 of NSTXU_1-1-3-3_CALC-101, *Machine Core Structures: Alignment and Tolerance Stack-Up Assessment*. This is based on assessments of the prototype coils. These are a small part of the overall tolerance budget, and it is not likely that this provides any challenge.

The RWM coils are dominantly defined to correct n=1-3 error fields that are of system-size scale. The act of cancelling a local divertor error field with those coils would apply an enormous n=1 field that would be seen by the rest of the plasma as a massive error field; this is clearly impractical.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Project PDR	PROJPDR21	The coil insulation turn-to-turn design has co-wound 5 mil glass and 3.5 mil Kapton design. Does the 5 mil glass allow sufficient wicking of the epoxy to form a acceptable bond between the insulation and the copper conductor?

The insulation system utilized in the production coils is identical to that used in the prototype coils. Experience with those prototypes showed that an excellent VPI is indeed possible. Therefore, it appears that yes, the insulation systems does allow sufficient wicking if the VPI is done properly (milking, allowing the resin to soak, etc.)

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Project PDR	PROJPDR19	Recommend using the existing prototype coils to verify modulus and CTE of the smeared packs used in the analysis models. Various numbers were stated at the review in terms of what is being used which should be a range for both modulus and expansion. The exiting prototypes could be cut into smaller pieces for placement in an MTS machine to verify these values.

Material testing was performed on smaller samples at Composite Technology Development to determine the range of material properties. These are described in the test report for PE-015927-D, and also the memo MAG-180323-IZ-01. These are available on the FDR web site (https://sites.google.com/pppl.gov/pf-coils-fdr/home), in the documentation folder. These values are used for design. It is not necessary to further assess these using sections of the prototype coils.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Project PDR	PROJPDR22	Erosion/corrosion issues are enhanced when there is a discontinuity in the flow passage. If the 90° elbows are to be manufactured the review of discontinuities should be evaluated and added to the Risk matrix.
Project PDR	PROJPDR20	Water flow in copper coil conductors can lead to erosion/corrosion issues if the velocity is too high. Design requirements should be developed identifying maximum allowed water flow velocity. There is a temperature dependence of this phenomena and this should be included in the requirements

Flow velocities were verified to be below 10 ft/s making erosion issues inconsequential.

, this chit can be closed. (Rev. 0).

Review	ID	Chit
Magnets DVVR	MD06	Consider applying an additional pressure in the mold to collapse the voids. Minimum 2 bar gauge or higher

Additional pressure was considered during the prototype process. The design of the mold and the techniques used by various vendors had to be considered and moderate positive pressure was applied in some cases but in other cases the techniques used to seal the mold presented unwarranted risk if positive pressure was applied. The results of the VPI using these approaches was evaluated via destructive testing and the vendors techniques are being approved based on those results. The quality of the four PF1a prototypes was not a function of the pressure of the mold.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Magnets DVVR	MD12	The testing of the magnets in support of validating the components started but is not complete. In addition to the instrumentation plan, a plan for validating the models including a test plan is needed.

The prototype coil was tested using a test plan and procedures. The impulse testing and turn-to-turn test results were compared to calculated results from coil modeling.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Magnets: PF1A PDR	PF1APDR04	Develop an inspection plan for ensuring fabricated components and assemblies meet the required tolerance in the drawings.

With regard to PF magnets, metrology was performed on all of the prototype coils based on inspection plans developed by vendors and approved by PPPL or developed by PPPL for the PPPL prototype. Inspection results demonstrated that required tolerances can be met.

If this chit is meant to address inspection in general, then yes, the project works with QA to develop critical characteristics, including obviously required dimensional checks.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Magnets: PF1A PDR	PF1APDR06	Investigate possibility of increasing number of turns by reducing dZ of thick flanges. Determine feasibility, programmatic impact, physics benefit.

It was determined that the physics benefit was not significant enough to warrant changing the design. This chit is obsolete based on the mandreless design.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Magnets: PF1A PDR	PF1APDR11	The PF1 coils and their associated buswork are apparently being reviewed independently, but there have been bent PF1A coil flags and also bent buswork. Due to the strong mechanical coupling between the PF1 coils and buswork, and the complex thermal and EM loads, the Recovery Project should consider a tighter coupling of these reviews and requirements, or explicitly include the buswork in the coil design reviews up to the point where the forces on the coil system are small, i.e. until the bus leads are outside the TF (for example).

The Inner PF FDR included an analysis of the bus work that was sufficient to determine the forces on the Inner PF Coil Flags and to complete the Inner PF Coil stress analysis. The Bus Work analysis leading to the Bus Work FDR also included the Inner PF Flag Stiffness so that the interface of the two areas overlapped at each review. In this way it was ensured that stresses both in the Coil and at the Bus Work near the coil were properly evaluated. The integrated design and analysis ensured that these components properly interfaced.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Magnets: PF1A PDR	PF1APDR19	If the prototype will be started before the FDR is completed, consider holding a peer review for the prototype.

A separate Prototype FDR was held for the PF Prototype 6/7/17

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit

Magnets: PF1A PDR	PF1APDR20	If there is a new PF-1AL, the coil lead support system needs presentation of design and analysis at a greater level of detail than presented at this review (PF-1AU PDR).
Magnets: PF1A PDR	PF1APDR18	Lead supports were not covered in this review. The design and calculation needs to be addressed by FDR.

The combination of the coil FDR and the PF Bus Work reviews covered the coil lead support system in detail.

The coil FDR is here: https://sites.google.com/pppl.gov/pf-coils-fdr/home

See in particular the talk by Zhai at that review, and also calculation NSTXU-CALC-55-0, Inner PF Coil Leads and Bus Bard Analysis, by Y. Zhai and T. Willard.

The coil leads and bus bar are further evaluated in their design cycle, including the PDR for bus bar design: https://sites.google.com/pppl.gov/20181025-pf-bus-work-pdr/home

The FDR for that scope is upcoming, likely in January of 2019.

Therefore, these chits can be closed. (Rev. 0).

Review	ID	Chit
Magnets: PF1A PDR	PF1APDR22	The existing PF-1AL, which is to undergo full power testing in the FCPC, needs a lead support system that should be reviewed prior to the tests. This is out of scope for the PF-1AU PDR, but need to be addressed soon.

A lead support system and test stand was developed and the design was signed off and tested. This is described in the talk by Zhai, at the power testing FDR (https://sites.google.com/pppl.gov/inner-pf-coil-power-test-proto/home).

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Magnets: PF1A PDR	PF1APDR30	Installation procedure for connection from coil leads to bus should include a signoff step and hold point for a high voltage insulation expert to ensure that the as fielded condition is satisfactory.

This requirements will be verified by the high voltage engineer and a sign off will be included in the installation procedure.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Magnets: PF1A PDR	PF1APDR31	Concern that the point where the lead emerges from the mandrel may present risk of insulation failure. To minimize risk, VPI should extend beyond this point, and G-11 added, if possible. May also be

		desirable to round off the sharp edge of the mandrel.

This chit is the result of a PDR on the old design of the coil when it had a mandrel. The coil was redesigned without a mandrel and another PDR (and FDR!) for the updated design was held. This chit does not apply to the new design.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Magnets: PF1A PDR	PF1APDR34	Check weld stress on PF1A mandrel. In particular, on slide 67 of P. Titus' presentation, there is a "greyed out" band which is above the stress contour levels near the joint between the flanges and the tube. Investigate the weld stress in this region, especially due to a "hinging effect" whereby the flange tries to rotate about the weld.

This chit is the result of a PDR on the old design of the coil when it had a mandrel. The coil was redesigned without a mandrel. The mandrel has been replaced with slings, which have been qualified. Therefore, this chit does not apply to the new design

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
PF1 Conductor Size Peer Review	PF1CONDPEER 01	The TF/PF tight/loose discussion is based on a xls. Very little detail of the workings of the xls was discussed. How was the tool validated?

This is not a coherent chit. One presumes that “a xls” refers to a spreadsheet, though this is unclear. In any case, the PF-1A conductor has been purchased, fabricated, primed, shipped to the vendor, and will be wound on coils in a matter of weeks. The radial clearances have been heavily studied, for instance, in the presentations by Smith at the MCS FDR (https://sites.google.com/pppl.gov/20190725-mcs-fdr/home) and at the PF-1a sling/belt peer review (https://sites.google.com/pppl.gov/20191205mcspf1aslingbeltdesign/home). The radial clearances are tight, but adequate.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
PF1 Conductor Size Peer Review	PF1CONDPEER 02	Consider incorporating self-centering features to alignment adjustment designs so that component positions do not shift during bakeout thermal cycles. The concern is that oversize holes or slots that accommodate alignment during assembly could permit thermally driven shifting during/after bakeout.

Radial slots that interface with the PF Coil supports provide a self centering feature. The coil polar region assembly are being design to include the tolerancing of the bolt holes, with some tightly toleranced holes an intrinsic centering feature. See , for instance, the presentations by Smith at the MCS FDR tes.google.com/pppl.gov/20190725-mcs-fdr/home), or the alignment tolerance study by Kunsch: NSTXU_1-1-3-3_CALC-101, *Machine Core Structures: Alignment and Tolerance Stack-Up Assessment*

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Polar Region Design Integration Peer Review	POLARPEER11	Please discuss with Menard if more Cu should be used in the -1c coils by removing SS on the cap, at the expense of moving the coil centroid a little farther from the plasma.

Due to the mandreless design adopted follow the Integrated Design Review, this chit no longer applies.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
PF1A Mandrel-less Prototype FDR	PROTOFDR04	Prototyping process should include training/exposure of all relevant coil personnel in anticipation for two shifts.

Prototyping was completed successfully and coil personnel involved received training in preparation for fabrication of the production coils.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
PF1A Mandrel-less Prototype FDR	PROTOFDR05	Winding contamination: No nails, screws or paper clips, anything irrelevant in the pockets

During prototyping effort procedures were generated to enforce proper clean room etiquette to ensure that contamination was kept from the clean room.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit

PF1A Mandrel-less Prototype FDR	PROTOFDR06	Explore the adequacy of using an o-ring for sealing on both vacuum and pressure for the VPI mold.

Different methods were used to seal the vacuum molds depending on which vendor was fabricating the prototype coil. The PPPL Mold was proven capable of operating at high vacuum to 3 atms. Some vendors used O-rings but others used finely machined surfaces with RTV and no o-ring. It was determined that the vendor should use the method that was standard for their operation so as not to force a method that was outside of their comfort zone. The efficacy of the techniques that were used was demonstrated in the final prototype coils that were subsequently tested and cut open to show the quality of the VPI.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
PF1A Mandrel-less Prototype FDR	PROTOFDR09	Review vacuum leak rate and manufacturer's recommendations on maximum/minimum vacuum levels.

Each vendor (and PPPL) had to provide Manufacturing Inspection Test Plans which detailed allowable leak rates and vacuum levels. These procedures were reviewed and approved by PPPL

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
PF1A Mandrel-less Prototype FDR	PROTOFDR10	Check the temperature in the VPI procedure (45 C vs ?)

A detailed curing temperature cycle was prescribed to all of the vendors. Vendor procedures were reviewed and approved by PPPL checking that the temperature and time in the oven was correctly applied.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
PF1A Mandrel-less Prototype FDR	PROTOFDR11	Cure time for VPI is labeled as 24 hours. Verify the duration (10 hours has been used in the past). Also verify other durations of the epoxy cycle.

A detailed curing temperature cycle was prescribed to all of the vendors. Vendor procedures were reviewed and approved by PPPL checking that the temperature and time in the oven was correctly applied. Longer cure times were applied before jelling to maximize penetration of the resin.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
PF1A Mandrel-less Prototype FDR	PROTOFDR16	O-ring sealing concerns during Milking. Varying pressure during milking may result in o-ring movement in the groove that will cause sealing issues during the cyclical milking process.

Different methods were used to seal the vacuum molds depending on which vendor was fabricating the prototype coil. Some vendors used O-rings but others used finely machined surfaces with RTV and no o-ring. It was determined that the vendor should use the method that was standard for their operation so as not to force a method that was outside of their comfort zone. The efficacy of the techniques that were used was demonstrated in the final prototype coils that were subsequently tested and cut open to show the quality of the VPI.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
Vacuum Vessel & Internal Hardware DVVR	VVIHPP08	I recall in the Magnets DVVR getting Stefan and Irving Zatz together about this high temperature resin-like insulation system, prototyped in a simple geometry by PPPL for putative JET in-vessel RMP coils, but I don't recall if I chitted this option then. JET bake-out is also 350 deg C average, with hotter spots up to ~400 deg C. Of course, even if you produce PF1C coils that can tolerate this temperature, you need to change the near-by vacuum seals to Helicoflex/Cefilac!

With the new design in all cases the coil supports and or case is decoupled and insulated from the surface heated during bakeout. Therefore the coils do not approach 100C and have a lot of margin with respect to their peak temperatures. It is not necessary to consider higher temperature resins.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR003	Procedures to achieve high quality bond between fillers and glass tape of the winding pack (inside the ground wrap for winding fillers, and outside the ground wrap for grooved sliding pads) require qualification, i.e. mechanical testing. Procedures to be established are for cleaning and for achieving the optimum surface roughness.

The process used produced good results for the prototype coils, and is therefore considered to be qualified.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR007	Weiguo Que said that previous operation featured a steady decline of insulation standard of the coil cooling water during operational periods. Does this imply a need for the introduction of (or improvements to) the water "polishing" system, operating continuously?

This is an incorrect statement. There is no systematic decline during operations, though the results regarding water conductivity may fluctuate from day to day. There is a maximum conductivity defined in the water system requirements and the system is maintained below that maximum conductivity during operations.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR044	Consider installing cameras to record the coil manufacturing process for either real-time analysis (using computer vision) or review. It may be possible to catch defects in early in the process with sufficient monitoring and analysis. Some of this could be automated. There are researchers who have experience with tracking "features" (blobs, dust) inside of NSTX-U who could potentially assist with this effort.

The coil manufacturing process during the prototyping phase was monitored with on site engineers who were instrumental in finding areas where potential problems could develop. For the overall surveillance of the room it would be impractical to have automated monitoring as there are too many non-repetitive tasks that take real time intelligence to catch the issue. We are using a computer vision system to inspect the insulation before application and that has been successful.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR084	Design the collapsible mandrel and VPI mold for the prototype in such a way that changes in the dimensions of the final coil design do not preclude re-use of the prototype tooling. This can be ensured by designing shims, wedges, flanges, etc. so that they can be customized to suit a larger or smaller size coil.

The prototype fixtures for the PPPL coil were designed in such a way that they could be used for the PF1a production coils (with some minor modifications). The # of mandrels being fabricated at Sigmaphi is set by their need to keep two winding lines open.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR085	Include features that facilitate the removal of the wedges so that there is no chance that the wedges get stuck.

The PPPL prototype design includes threaded holes so that the wedges can be grabbed and pulled out. Sigmaphi has a separate method specific to their tooling.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR086	Consider potting the lead block volume with RTV pre-VPI to avoid resin-rich volume and facilitate post-VPI cleanup.

The lead block volume are filled with steel blocks to avoid resin rich volumes. These blocks are better than RTV because they also acted as heat sinks to reduce the probability of an excessive exothermic reaction.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR087	There was a brief discussion about how the ground wrap of the coil would be applied without removing the coil from the winding former. The proposed solution seemed to feature separate pieces of glass fibre for the inner, upper, lower and outer surfaces, but we were not shown how these were butted together to avoid resin-rich regions at the corners where these pieces meet.

The ground wrap was intermittently overlapped from the top to the sides during fabrication of the prototype coils. PPPL worked closely with outside vendors and paid close attention for the in house fabrication to make sure there were no resin rich areas in the corners. Similar techniques will be repeated for the production coils.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR089	Evaluate and implement best method to protect taping station from contamination.

At the prototype vendors the winding line including the taping station was fully enclosed in the clean room. At PPPL extra protection and plexi glass shields were added to protect the taping heads for the prototype

For the production coil, the entire winding line at Sigmaphi is within a clean room.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR090	The ground wrap of PF1 coils seems to be composed of toroidal wraps at the inner and outer diameters and flat sheets covering the top and bottom surfaces. It is not clear how the junction between toroidal wraps and top/bottom sheets will be arranged in order to provide adequate overlap between insulation layers without excessive local overthickness.

The ground wrap was intermittently overlapped from the top to the sides during fabrication of the prototype coils. PPPL worked closely with outside vendors and paid close attention for the in house fabrication to make sure there were no resin rich areas in the corners. Similar techniques will be repeated for the production coils. We were able at two out of three vendors to achieve the proper thickness. One vendor did have some local over thickness but this can be avoided with greater attention to this area lessening the number of layers applied.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR093	Consider partial discharge measurements to be carried out at regular intervals on coils as a diagnostic to assess ageing of the ground insulation (this would require disconnecting coils from bus bars).

This chit pertains to operations scope; while a good thing to consider, it has no role in the finite scope Recovery Project.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR094	Discussion of split core and surge testing seems to be either one or the other with advocates for each method. Is there consideration of split-core + surge, especially considering the ability to baseline using surge and then check the installed coil to see changes in signature.

The plan the project has adopted, and utilized in the context of the prototype coil program, is to do surge testing of the coil. The split-core method was not adopted by the project.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR095	Application of an époxy varnish on the coil outer surface after VPI is recommended to fill all micropores or microcracks. This is all the more important if a semi conductive paint is to be applied as a ground plane: the semi conductive paint in micropores would act as a field intensifier.

There is no plan to apply conductive paint. The surface finish from the best vendors and PPPL was very good and the varnish is unnecessary.

Therefore, this chit can be closed. (Rev. 0).

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR096	When checking the AC impedance of the coils with a voltage drive from an AC voltage generator, the self-resonant frequency would be a good indicator of the total number of turns. Also, the Q dropping would reveal a resistive short, and any discontinuities with respect to the drive voltage amplitude would indicate a threshold break-down between turns or layers. I think Q could be determined with high accuracy before the coils are put into the machine, and possibly could remain a useful test despite the resistive shorts of the vessel flanges etc. pulling it down when the machine is assembled.

An extensive study was done of the various methods of testing coils; see presentation by C. Neumeyer at the turn-to-turn testing review. The conclusion was to rely on surge testing. This was done for the prototype coils with good success, and will be done for the production coils.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR100	Suggest to do the thermal and insulation tests on inner PF coils up to the max operation temperature. Also for the turn-to-turn test, the core loss and field leakage of split-core transformer are suggested to be analyzed with different frequencies.

Testing for prototype coils on the FCPC test stand brought them to the full operating temperatures. It is expected to do similar for the production inner-PF coils as part of their final qualification before installation in the machine, though the exact details of this testing have not been defined.

As for turn-to-turn tests, the split-core transformer method was not adopted. Rather, surge testing provides the primary test of the turn-to-turn insulation, with measurements of the complex impedance as a function of frequency providing a secondary assessment.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDO16	Belleville washers to maintain vertical preload on OH solenoid: What is the required vertical preload and for what purpose? How much preload reduction is expected after cool-down due to the different thermal contractions of the TF bundle and of the OH stack (which include many insulation layers)? How are Belleville washer stacks preloaded in the gap between OH solenoid and TF lead extensions?

This is not a chit. It is a series of questions, none of which imply any modifications should be made to the design, and none of which point out any issue. Typing answers to them here will not inform the person who asked the questions.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Magnets DVVR	MOPF07	PF4 and PF 5 analysis shows high stresses, but seems like the operating space has not been determined yet. Also, from the past experience it was not clear if the coils were subject to high stress in their history. Define operating space and enter into the interlock system

It is not exactly clear what this means. The PF-4 and PF-5 operating space is well defined, and is incorporated into the interlock system. The set of protection algorithms used in 2016 operations, and anticipated for future operations, includes the following.

- Coil current limits, established by DCPS algorithms 32 and 33. The limits here are derived from the DPSS. Note that the PF-5 has been qualified to 34 kA, but is presently limited to 24 kA due to the power supply configuration; applying >24 kA would require a major investment in the facility to basically double the power supply capability.

- Ohmic heating limits, established by DCPS "Action" algorithm (Algorithm #2). These limits are set based on the desired maximum temperature of the coil. The core research program can be done with a maximum temperature of around 60 C (see MAG-190506-SPG-01), though higher temperatures have been qualified (NSTXU-CALC-12-05-00).

- Vertical force limits have been established by the design process and documented in the Design Point Spreadsheet (DPSS). These are then established in the DCPS as algorithms 7-9.

- Radial force limits are established in DCPS algorithms 3-6. Limits are set based on NSTXU-CALC-13-07-00

- Bending stress limits are established in DCPS algorithms 18-20, based on the information and limit in the calculation NSTXU-CALC-12-05-00.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Vacuum Vessel & Internal Hardware DVVR	VVIHPF45S07	If I understand correctly, the PF4/5 coils are connected to the vacuum vessel at 6 equidistant locations. This means that the error field associated with the thermal expansion of the coil has a periodicity n=6, not n=2. I suspect that this higher n perturbation will not provide an error field problem. Confirm this through plasma response modeling of the modeled (engineering) displacements of the coil.

First, the way the slides are set up, the coil takes an oval shape, which means it is n=2 dominated. This is heavily documented in, for instance, the Upgrade era calculation Analysis of Existing and Upgrade PF4/5 Coils and Supports – With Alternating Columns (NSTXU-CALC-12-05-01), or the more recent Recovery calculation PF4/PF5 Pancake Clamp Analysis (NSTXU_1-1-3-1_CALC_100).

It is not in project scope to make an assessment of NTV, either with n=2 or n=6; indeed, this modelling would not even be conclusive, given the research nature of NTV calculations. The Project position is that with six SPA sub-units, is is possible to rotate the phase of an applied n=2 correction field however is necessary to correct the n=2 from the thermally grown coils. This will be assessed in detail as part of the research program.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
NSTX-U Recovery Project - CDR	RPCDR014	Indefinite deferment of CHI does not mean elimination of CHI in the design criteria for NSTX-U. (An optimist would hope that with CHI, the OH coil would not be needed, but it is likely that it will be required for experiments to study the Physics of CHI, does this require a higher insulation than the 4 kV that is proposed?) It is important to preserve the NSTX-U capability of performing CHI in the future. Someone in the US Senate is paying attention to NSTX-U as evidenced by the Senate's budget that contains language calling for a speedy resumption of operation and for a review of what unique capabilities NSTX-U provides, presumably as a possible shut-down of NSTX-U if it fails either to operate soon or fails to be unique enough. I think PPPL ignores the US Senate at its peril. Elimination of one of the CHI insulators makes eventual CHI experiments on NSTX-U more uncertain as it would require either reinstallation of the insulator, success of plasma guns to scale up in current or installation of an insulated electrode inside the vacuum vessel. I think the evidence is that plasma guns have limited current capacity due to their small area and that is a primary reason PEGASUS experiments have as yet been unable to propose a solution for NSTX-U. While QUEST is working on an in-vessel electrode configuration for CHI, it is not yet clear if it will be successful or what engineering issues may arise with this approach. The ability to perform CHI experiments is clearly a

		unique capability of NSTX-U. That leaves the present NSTX-U vacuum vessel breaks as the only proven technique that both scales up in current and is proven to actually work. Note, there was no evidence on NSTX of any degradation of the CHI insulators, no evidence of Li coating the insulator on the bottom and no evidence that tokamak debris accumulated in the CHI gap in a sufficient amount to compromise the insulator. The complaint that the single O-ring seals caused unacceptable permeation is questionable since only about ½ the linear feet of single O-rings on NSTX-U are due to the CHI regions. Also one of the polar-region O-rings was not fully compressed due to a design error that will be fixed in future designs with or without insulators. So far as I can tell, no one has been able to present a clear technical reason for removal of the bottom CHI insulator from NSTX-U. From my perspective, the concerns about the CHI insulators mostly fall into the category of "I am uncomfortable with them." I do not believe that is a good reason to modify the NSTX-U vacuum vessel, no matter who holds the opinion. Changing the vacuum vessel unnecessarily will take time and cost money than could be better used for other much more essential tasks. If we are to take the "feelings" about the insulators seriously, how can it be acceptable to keep one? The fear that Li will contaminate the insulator is given lie by simple examination of the insulators used on NSTX which appear pristine with no evidence of Li or of tracking.
NSTX-U Recovery Project - CDR	RPCDR027	Indefinite deferment of CHI does not mean elimination of CHI in the design criteria for NSTX-U. See Chit on Neumeyer's presentation summarized below: It is important to preserve the NSTX-U capability of performing CHI in the future. Someone in the US Senate is paying attention to NSTX-U as evidenced by the Senate's budget that contains language calling for a speedy resumption of operation and for a review of what unique capabilities NSTX-U provides, presumably as a possible shut-down of NSTX-U if it fails either to operate soon or fails to be unique enough. I think PPPL ignores the US Senate at its peril. Elimination of one of the CHI insulators makes eventual CHI experiments on NSTX-U more uncertain as it would require either reinstallation of the insulator, success of plasma guns to scale up in current or installation of an insulated electrode inside the vacuum vessel. The ability to perform CHI experiments is clearly a unique capability of NSTX-U. That leaves the present NSTX-U vacuum vessel ceramic breaks

		as the only proven technique that both scales up in current and is proven to actually work. To the extent that reworking the polar regions costs money abd takes time, it does not help in regard to the time until NSTA-U operates again.

The decision was made to eliminate the upper insulator, as described in the document NSTX-U-DOC-001-01. On that grounds, there appears to be little reason to respond to the details of this chit.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Polar Region Design Integration Peer Review	POLARPEER51	One has to be careful with oscillating currents in large coils. Localized hot spots could form in regions that are difficult to model, and these may not become apparent until after the machine starts operating.

This chit is written regarding previous notions to oscillate the current in the OH or TF coils as a part of the bakeout heating scheme. However, as described in the document NSTX-U-DOC-001-01, this scheme was eliminated from consideration.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Polar Region Design Integration Peer Review	POLARPEER54	Consider minimizing the duty cycle on the OH coil until a spare OH coil is available, and a plan has been developed for speedy replacement of the OH coil.

We have made the decision to not use the OH coil for purposes of bakeout. Beyond that the OH coil is required to be pre-charged, and to swing rapidly for the breakdown and current-ramp, on every NSTX-U discharge. So while we limited the current to ~21 kA in the previous run (compared to a rating of 24 kA), it is not possible to avoid heavy use of this coil while completing the mission.

In any case, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDD15	GRD 3.5.2.2 indicates PF-2 is bipolar. It isn't, though I wish it was. At this point, the GRD should likely be abstracted in this area, since things like power supply polarities can be changed as part of the research program.

The SRD has been corrected, as per statement 6.5.2.3.2a. It states there that although PF-2 will be unipolar i initial operations, there shall be no design choices which prevent a bipolar upgrade in the future.

Therefore, this chit can be closed. (Rev. 0)

CR-*SEI*-12 – *Heating/Cooling*

Review	ID	Chit
Integrated Design DVVR	IDD16	MAST-U makes good use of Galden, as does JET, to pre-cool the coils of most interest for their I2T limit, to say -20 degrees C. This requires a dry-gas environment (a shrouded enclosure) for the centre stack, to prevent condensation creating surface tracking near the coil connections.

NSTX considered sub-cooling its TF coil, so this idea is not foreign to PPPL. Sub-cooling the TF might indeed be advantageous in maintaining the state $T_{OH}>T_{TF}$, as required by the aquapour consideration; this might help with achievement of high-current long-pulse shots in the future.

This would complicate some aspects of thermal management of the TF coil. The inner-TF is plumbed in series with the outer TF, so that the water that cools the inner-TF at the end of a pulse is “pre-warmed”, thus reducing the thermal stresses around the cooling tube. It is impractical to maintain the outer bundles in a dry atmosphere, so this plumbing scheme would need to be revisited if the inner-TF were subcooled. Further, the temperature of the Galden would likely need to be time-varying to minimize the thermal shock (unless the slower cooling with Galden had the same effect of reducing thermal stresses). The slower cooling time would also need to be examined from the view of the $T_{OH}>T_{TF}$ constraint, where the rapid TF cooling provides considerable fault tolerance. Finally, the thermal tensile hoop stresses that the bundle experiences would be exacerbated if the ends of the bundle were cooler than in the analysis used in the summer-2019 inner-TF review.

The point here is that the benefits to the program would need to be weighed against the technical complications introduced. Certainly, no component of the defined Recovery engineering scope utilizes any subcooling.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDO12	Mixed use in-vessel pipework (hot helium and cooling water - at different times), corrosion issues?

This has been the practice at NSTX-U for the life of the project. This issue is resolved by the use of extensive blow-down and drying cycles before He is introduced, and no corrosion has been observed. Note that this transition only occurs a small # of times in the lifetime of the facility (basically one a year).

, this chit can be closed. (Rev. 0)

Review	ID	Chit
Polar Region Design Integration Peer Review	POLARPEER06	Examine technical justification and assess potential of reframing prohibition of in-vessel water cooling in way which remains safe but allows additional design flexibility. (For instance, require double barriers around water flow),

This is exactly the approach taken in the Recovery GRD. Water is allows in-vessel if there is double containment. See GRD 4.1.5d for the full policy.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integration PDR	INTPDR02	Normal cooling provisions for the TF and OH have an interlock to prevent the Aquapour from being over-squeezed (and the OH coil stretched), but if there is a power cut, the emergency potable water cooling is only specified to be applied to the OH, not the TF inner legs as well.

This chit is correct, but may represent a confusion on the part of the chit writer.

The “normal” cooling provision for the TF and OH are related to coil operations, where it would be natural to operate the TF coil without first heating the OH (for instance, TF-only magnet calibration pulses). This combination (hot TF, cold OH) would put undue stress on the OH coil. See calculation NSTXU-CALC-133-16-00. For this reason, an interlock exists to prevent this operations mode.

The emergency potable water, however, is a feature of bakeout operations. During bakeout the TF is cooled, as are the outer one or two layers of the OH. Ideally, only the outer layer is cooled, in order to ensure there is no radial temperature gradient in the OH; in this case, the cooled outer layer serves as a “heat barrier” to the inner layers. Hence, the OH coil is hotter on average than the TF, and the aquapour considerations are accounted for.

If there is a complete power loss during bakeout, the cooling water can stop, and the heat from the casing would soak into the OH coil, potentially damaging it. Hence the need for cooling of the OH coil. The inner-TF is shielded from that source of heat by the OH coil, and so need not be cooled.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integration PDR	INTPDR06	Water in the vessel was said in the DVVRs and EoCR to be proscribed, but is it routinely used for cooling the NBI armour? If so, does that raise any special design considerations?

The in-vessel water cooling policy is stated in 4.1.5d of the GRD. This policy provides limited opportunities for use of water-cooling inside the vessel. As per that policy, water cooling could be used for the armor, efore Li is introduced to the vessel. After that point, gas He (or other) cooling of the armor would ed.

Note that no water or gaseous cooling was used on the armor in the 2016 run campaign, and no undue temperature excursions of the armor were found. Therefore, this cooling limitation is not expected to be problematic for future operations.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integration PDR	INTPDR08	Did the fluid - flow analysis of the heating/cooling systems (helium/water) appropriately account for the as-installed delivery system (piping) lengths, bends, regulators, valves, etc?

This chit poses a question instead of making a recommendation. And no, such flow analysis is not in general required by the Project.

For the coil flow calculations DPSS, the coils themselves typically present the dominant impedance. As such, these other effects play a smaller role in setting the flow. However, there are places where additional flow apertures are postulated to exist, namely to balance the cooling wave front on the OH, and to limit the flow in the TF. These are captured (approximately) in the DPSS.

For the He system, J. Petrella has done some calculations as a matter of completing his design improvements for the fast piping system. Those can be found in his PDR presentation here: https://sites.google.com/pppl.gov/gas-piping-pdr/presentations

Finally, such flow analysis for its own benefit is not part of the Project scope as defined in the WBS dictionary.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integration PDR	INTPDR09	Check impact with regard to dimensional changes due to VV temperature which could float upward affecting diagnostics alignments like MPTS

Review	ID	Chit
Integration PDR	INTPDR11	In the water cooling system SRD, more than once it mentions the need to keep the water pressure "at" a value which suppresses boiling, but there is no caveat that the calculated value needs to allow for Bernoulli drop due to flow speed around corners, as well as the pressure drop through the cooled component.

ct that these physical effects are valid, and that they are not mentioned in the SRD. However, g all potential design considerations is not the point of the SRD. For instance, the SRD does not admonish the reader to beware of stress concentrations at sharp corners. This is all in the space of engineering design and practice.

It is also worth noting that no magnet system is designed to operate above 100 C, so this is all rather academic.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integration PDR	INTPDR12	A slide described that the IBHD requiring cooling for baseline operations. This requirement will drive additional scope to vet the helium system for electrical isolation which is presently not required during helium system operation. Ceramic breaks exist in the helium piping but they are removed during operation of the bakeout helium skid. Assess whether cooling will be required for IBDH baseline operation or if it can be part of a future upgrade. If determined to be required, the helium system requirements will need to reflect this baseline requirement.

The design presented for the IBDH cooling interconnections (https://sites.google.com/pppl.gov/20191204htt-htpcoolingwatercon/home) has ceramic breaks to facilitate the use of He for the HTP even during normal operations. The He skid is already capable of heat exchange with tower water (indeed, that is a base capability done even during bakeout). Hence, the system will be able to support cooling of the horizontal targets as needed.

CR-*SEI*-13 – *Vacuum*

Review	ID	Chit
Vacuum Vessel & Internal Hardware DVVR	VVIHBI09	It was said that if CHI became unpopular, few of the present O-ring seals could be obviated because of the need to isolate the centre tube from the outer shell in order to pass a Joule heating current along it. MAST and COMPASS, at least, use AC drive of the water-cooled tokamak OH solenoid to heat the centre tube by AC induction, so require no insulating gaps at the upper or lower poles of the vessel. In the discussion that led to this chit, the alternative option of putting AC into the TF coils was mentioned. (This can be problematical regarding poloidal distribution of the induced current.)

The use of the OH or TF coil to inductively heat the vessel was addressed in the document NSTX-U-DOC-001-01. The cost-benefit analysis shown in that document indicates that retention of the DC current bakeout scheme and upper ceramic insulator is the desired path.

, this chit can be closed. (Rev. 0)

Review	ID	Chit
Vacuum Vessel & Internal Hardware DVVR	VVIHCP15	Are there guidelines for trap volumes inside the primary (only) vacuum?

CR-SEI-15 - *Specification*

There are no specific articulated guidelines for trapped volumes. In general, these are avoided in system design, as part of the standard design process.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDR16	Specifications are given for the average and peak heat flux on the first wall. No specification is given for how these shall be connected, or which number should be used. Is it correct that the peak value should be used everywhere?

This chit is with reference to how things were specified in the Upgrade-era CS GRD.

For the Recovery Project, first wall heat fluxes are specified in detail in the document NSTX-U-RQMT-RD-003, which flows from the GRD power balance requirements. These specifications have been used in all Recovery calculations.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integrated Design DVVR	IDR18	Perhaps I missed it, but I did not see a high-level specification that called for the minimum toroidal loop resistance or maximum induced toroidal current (or some equivalent spec) in 'passive PF coils structures' (e.g. mandrel) that encircle the center stack. In view of issues related to copper cooling coils and a thick center stack casing, such a specification is particularly important.

This chit is with reference to how things were specified in the Upgrade-era CS GRD.
The Recovery GRD has the following statement in

"4.2.1.3c. Toroidally continuous passive structures shall be minimized to the extent that other design constraints permit, and shall be made of high resistivity materials (316 SS, Inconel) where compatible with component function."

ermined in writing this that a specific numerical target would be difficult to specify, so more uidance could be given.

Therefore, this chit can be closed. (Rev. 0)

CR-*SEI*-15 – *Passive Plates/Structures*

Review	ID	Chit
Integrated Design DVVR	IDR25	Passive structures: - are they top bottom symmetric? - where they included in the EM calculations to determine loads? - are the changes due to the newly identified passive structure sufficient to require different EM calculations? - disruption EM loads seem to come from simulations... are there locations where measurements existed in NSTX and are reasonably similar to these in the simulations... how do they compare?

There are a number of aspects of this ancient "chit" to be addressed (note that it is not much of a chit…)

- are they top bottom symmetric?

They are largely summetric, but there are subtle things like the OH skirt that are different.

- where they included in the EM calculations to determine loads?

Passive structures are indeed included, especially in the so-called VDE-loads, which augment the static vertical loads on the structures. See calculation NSTXU-CALC-10-07-1 "Global Disruption Simulations and Lorentz Force Data for Passive Plates, PF support "Slings", Bellows, Heat Transfer Plates, TF and OH Coils" .

- are the changes due to the newly identified passive structure sufficient to require different EM calculations?

Calculations for new design are being done using the Recovery machine configuration.

- disruption EM loads seem to come from simulations... are there locations where measurements existed in NSTX and are reasonably similar to these in the simulations... how do they compare?

At the time of the DVVR, the disruption calculation had not been compared to measurements. However, calculation NSTXU-CALC-011-08-00, *PFCs Fields and dBdts*, makes comparisons to the magnetic field measurements documented in NTC-170602-SPG-01. See that calculation for details of the benchmarking.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit

Vacuum Vessel & Internal Hardware DVVR	VVIHPP14	Passive plate disruption analysis doesn't include the tiles. As you bend the plates, this could create stress-concentrations around the tile bolts. Could have low-cycle fatigue in the tiles and mounting structures.

The passive plate tiles do indeed experience stress when the plates bend, however, this has been shown to be a small effect relative to the total stress on the tiles (from preload and from disruption loads).

This is documented in the calculation by B. Linn in the calculation NSTXU_1_1_1_1_6_CALC_101, *Structural Analysis of Passive Plate Tiles Subjected to Preload, Plate Deformation and Halo Forces*.

This calculation is in checking, but once complete, will be the official repository for this conclusion.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Project PDR	PROJPDR07	The people present in 318 appeared to have very different views about the possible effect on plasma initiation of adding the "yellow" passive plate brackets paralleling parts of the old brackets and adding the copper electrical straps enforcing a low-resistance path to the short lengths of VV wall between the brackets welded to it. I advise checking that with the intended modifications, the four rings of PPs don't generate too much vertical field during OH-only plasma initiation.

The memo SEI-191216-DB-01 shows that the passive plate jumpers will not be a problem as regards breakdown.

Therefore, this chit can be closed. (Rev. 0)

CR-*SEI*-16 – *Bus Bars*

No chits.

CR-*SEI*-17 – *Safety/PSS*

Review	ID	Chit
Integration PDR	INTPDR01	Safety is missing in the list of interfaces for the SRD. At least "credited controls" should have that.

Interfaces are connections between systems. “Safety” is not a system, and therefore there can be no to “safety”.

The spirit of the comment, however, is that systems assigned a safety significance should be noted as such in the Project documentation. This occurs in a number of ways:

- Safety considerations are central in the determination of the “Risk Classification” A1-A3, which determines the rigor of the QA process applied to the design, fabrication, installation, and testing of systems.
- Safety considerations are very clearly handled in the Project FMECA, where failure modes with bad consequences as regards safety are flagged.

Therefore, this chit can be closed. (Rev. 0)

CR-*SEI*-18– *CI&C*

Review	ID	Chit
Integration PDR	INTPDR07	I would expect there would be an SRD on data access, analysis and computing within the control room. There are aspects of data access and recording within the shot cycle that are critical for operations.

There is an SRD for the Central Instrumentation and Control System (NSTX-U-RQMT-SRD-009). Section 5 deals with the control room. Sections 7 and 8 deal with data I/O and data archiving. The individual who wrote this chit may not have known this, but in any case this is addressed.

Therefore, this chit can be closed. (Rev. 0)

CR-SEI-19 – Analysis

Review	ID	Chit
Integrated Design DVVR	IDR36	Check if the Opera dB/dt was ever benchmarked against NSTX data.

At the time of the DVVR, the disruption calculation had not been compared to measurements.

However, calculation NSTXU-CALC-011-08-00, *PFCs Fields and dBdts*, makes comparisons to the magnetic field measurements documented in NTC-170602-SPG-01. See that calculation for details of the benchmarking.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Project PDR	PROJPDR09	currently no tractability from analysis calc to analysis calc on loading. Please state loading and ref DAC by version # in the ICD.

It is not the Project position to track load cases via ICDs. ICDs follow the format described in the Interface Control Plan (NSTXU-PLAN-038).

The cover sheet of calculations, as specified in the PPPL procedure ENG-033, has places for both assumptions and references. This is the appropriate place to document the sources for loads within the PPPL system.

Therefore, this chit can be closed. (Rev. 0)

Review	ID	Chit
Integration PDR	IDR28 INTPDR13	specify design margins, analysis margins, and test margins for component requirements

The structural design criteria CIRT-001 provides design limits for all load cases. The results of structural integrity analysis and testing are compared with design allowables per the structural design criteria to ensure that designs meet requirements. These are presented at PDRs, FDRs, peer reviews, and similar.

Therefore, this chit can be closed. (Rev. 0)

CR-*SEI*-20 – *CAD*

Review	ID	Chit
Project PDR	PROJPDR12	For a PDR level review, there was not an abundance of drawings presented. Several designs past PDR did not have any drawings available to review but claimed to be >70% complete. Although a deep dive of the drawings is not needed or typically performed at a PDR, a list of the needed drawings (drawing tree) and a status of the drawings should be stated. List of analysis calculations and status should also be presented.

The policy at PPPL is that signed drawings only need to presented at the FDR. Therefore the review was consistent with expectations for a PDR per lab policy. Further, this chit is rather retrospective, with little to be done moving forward.

Therefore, this chit can be closed. (Rev. 0)

CR-*SEI*-21 – *Thermocouples*

Review	ID	Chit
PFCs-PEMP FDR	PFCPEMPFD R15	Add thermocouples where the casing bakeout thermal analysis shows critical strains and or temperature limits
PFCs-PEMP FDR	PFCPEMPFD R16	Consider adding thermocouples where the thermal analysis shows critical strain differentials or temperature limits

The main concern at the time of the PFC FDR was the small welds on the CSC and trying to protect them. With the full penetration welds in the casing, the concerns during bakeout are resolved. This is documented thoroughly in NSTXU-CALC-12-23-01 Revision No: 1.

Therefore, this chit can be closed. (Rev. 0)

CR-*SEI*-22 – *Toroidal Variation of Compression*

Review	ID	Chit
Polar Region-Inner PF Coil Supports PDR	PRIPFCS13	Magnetic Group must define the acceptable toroidal variation of compression -- to optimize the stud spacing, flange thickness of the sling support flange

This chit is left open in Rev. 0 of this chit resolution report

CR-*SEI*-22 – *Outer PF Algorithms*

Review	ID	Chit
Magnets DVVR	MOPF03	Check that the algorithm which protects the bolts on the outer PF mounting hardware has the correct accounting for upper and lower mounting locations.

The PF-3 U/L algorithm was checked in CALC-13-07-00 DPSS Check calculation. The document references two different algorithms one for the upper and another for the lower. In addition, separate upper and lower algorithms were created algorithms for the PF-2, PF-4, and PF-5 bolts.