PRINCETON PLASMA PHYSICS LABORATORY

CRR_CHITID - CHIT RESOLUTION REPORT

CHIT RESOLUTION REPORT FOR THE PASSIVE PLATE FDR

NSTXU_1-1-1-2-1_CRR_100

Rev. 1

Work Planning #:
Effective Date: **02/10/2020**
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Chit Resolution Report

for

Passive Plates

NSTXU_1-1-1-2-1_CRR_CHIT_100

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Record of Changes

Rev.	Date	Description of Changes
0	08/15/19	Initial Release
1	09/23/19	Added FDR CHIT resolution
		See chit resolution **CR-*VVHW*-2045** onwards

Table of Contents

PP Structure

Disposition Key:

A = Actionable
NA = Not Actionable
O = Out of Scope
R = Redundant

CR-*VVHW*-2000 - *Piping Stress*

Review	ID	Chit
Project PDR	PROJPDR18	Piping stress: Noting that 256 MPa (even with the Brooks brace) is quite high for a piping stress. According to Table K-1 of ASME B31.3-2010, the allowable yield stress for 316LN at room temperature is 205 MPa. 316L is slightly worse at 173 MPa. Is B31.3 the code of record for your pipe stress assessments? The actual allowable stress (membrane) in calcs actually would be 2/3 of the 205 MPa at 138 MPa for 316LN.

A The stresses do indeed exceed yield as noted. We are now qualifying the tubes/pipes for a limited life based on strain levels from an elastic-plastic analysis. Based on the ITER fatigue design curve for 304 ss we can tolerate 0.6% strain for 1000 cycles or 0.32% strain for 10,000 cycles. See analysis report NSTX-U recovery project Structural analysis report for Helium line bracket and Weld Evaluation - NSTXU_1_1_1_2_1_CALC_054 -A.Brooks

CR-*VVHW*-2001 - *Forces on Helium Tube*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESCDR14	Evaluate lateral forces and possible lateral motion of PP effect on He tubes

A Forces and effect of Passive Plate displacement on Helium tube were evaluated and found to be acceptable.See Analysis report “NSTX-U recovery project Structural analysis report for Helium line bracket and Weld Evaluation NSTXU_1_1_1_2_1_CALC_054 for data.-A.Brooks

CR-*VVHW*-2002 - *Passive Plate response due to slow current quench*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESCDR03	current disruption analysis use fast current quench, 1ms~4ms and use the load profile of 1ms changing load for dynamic structural analysis. But with slow current quench, although eddy current and force are lower, but when the frequency close to the natural frequency of passive plate (170Hz), is it possible that the passive plate produce

		even higher response?

A Loads don't change substantially for .001 and .002 second quenches, up to 4 millisecond quenches. See NSTXU-CALC-10-07-2 Figure 8.8-2. Drift times also affected loading, tending to reduce the load at the end of the drift (NSTXU-CALC-10-07-2 Figure 8.11-1) and increase it slightly at the end of quench. This is also shown in NSTXU-CALC-10-07-02 Figures 8.8-2, 3. All these variations in loading are enveloped by the design loads used for qualification of the passive plates reinforcements. . see report NSTXU-CALC-10-07-2 for data. -P. Titus

CR-*VVHW*-2003 - *Analysis model for Passive Plate loads*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 03	Presentation by Titus showed configurations which include the passive structure for the baffling for a possible future cryo-divertor. If these calculations are used to drive the design of the repair, they should be re-done without the effects of the cryo-hardware. If not driving design, strongly recommend future slides indicate only trying to get ball-park estimate of helium tube and other currents with cryo-hardware included. (Would have been better to run upward VDE simulations to reduce/eliminate effects of cryo-hardware)

A The Cryo-hardware shown in the model was suppressed in the latest analysis (ie all passive structure material properties were turned to have properties of vacuum - that is its non conductive). While it appears as part of the mesh it does not contribute to the solution.-P.Titus

CR-*VVHW*-2004 - *Toroidal resistance for Passive Plate loads*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESC DR09	For modeling of current flow due to VDE drift followed by quench insert a contact resistance (Rc) term so that the toroidal resistance of the 3-d model + Rc = fit values from J. Menard. Then if shunts are added across the bolts/studs to reduce the variability of resistance, include an equal share of Rc across each shunt.

A Modeling is based on uncertain resistance measurements and assumptions. Rather than try to model the contact resistances, actual resistance measurements will be made after installation and the straps may be re-installed with resistive shims to equalize the bracket resistance and to approach the resistance that allowed successful start-up and plasma stability in the 2016 run-P.Titus

CR-*VVHW*-2005 - *Stiffener with bolted connection*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 14	The stiffeners behind the plates are fastened via screw. It would be helpful to model the stress and deformation on the plate with the stiffener modeled as bolted with corresponding surface contacts and not fused the whole way. Also, this would lead to indication on sizing and preload of the hardware.

A FDR analysis was done as bolted connection. "See report NSTX-U recovery project Structural analysis report for Passive Plate additional support bracket, StiffenerNSTXU_1_1_1_2_1_CALC_052."

CR-*VVHW*-2006 - *As-built passive plate*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESCDR17	Don't assume all passive plates are identical. Need to measure each one to ensure plate-back stiffeners can be identical, or will need to build ribs tailored to match each plate.

A Plates were measured per D-NSTX-IP-4033. Most of the plates are within +/- 1deg, as stated in the drawings. Some stiffener will need field fit-ups.See report NSTXU_1-1-1-2-1_REC_101.

CR-*VVHW*-2007 - *As-built data in analysis model*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESCDR10	Ensure all the field recorded welding detail be reflected in the 3D Creo model/drawing also. All the components are bonded right now at the joints. In reality the joints vary from plate to plate in terms of gap, bolt location, etc. So the analysis should either catch the worse case of the as built condition, or based on the new design/repair that will be proposed later.

A At PDR, analysis models used that reflected the field changes. See PDR slides from Andrei. FDR uses same models.

CR-*VVHW*-2008- *Toroidal Symmetry*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESCDR16	Strive to maintain 12-fold toroidal symmetry for all passive plate electrical connections to bracket/vessel.

A Electrical straps are added at all locations. See analysis NSTX-U Recovery Project Structural Analysis Report for Passive Plate Shunt - NSTXU_1_1_1_2_1_CALC_053 and drawing E-DB1495

CR-*VVHW*-2009 - *Toroidal current in Plate*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESCDR18	Quantify toroidal current components from plate eddy currents and compare with net toroidal currents. Bracket resistance may not be as important as being discussed in the review.

A This is addressed in the physics simulations by Dan Boyer and Jon Menard. The memo from Dan Boyer,VVIH-190816-MDB-01, shows bracket resistance has more impact on plasma vertical stability/growth rate and can not be ignored.Physics simulations are axisymmetric and include the net toroidal currents on the top edge of the plates and the bottom edge of the plates, and the resulting net. At final installation(with new support brackets added) the “gap resistance” will be measured again and these simulations can be re-done if needed to predict the plate eddy current and plasma vertical stability/growth rate. -P. Titus

CR-*VVHW*-2010 - *Alternate design*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESCDR13	For mouse ears, concerned about complexity and reproducibility (aka toroidal symmetry) of the current path from plate to vessel and/or plate supports. It also appears to be up-down asymmetric, i.e. mouse-ears only goes on either top or bottom of plate, which will also change the current distribution in the plate during current ramp-up /down and disruptions. Need to carefully consider this complexity for both operations and for modelling/analyzing the configuration. Modifying the electrical connections only near the toroidal ends of the plates is arguably preferred for simplicity.

NA This concept was abandoned.

CR-*VVHW*-2011- *Add Electrical Strap*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESCDR07	To have better control over the toroidal electrical path, could isolate mounts and add a dedicated path. Could design path with adjustable (between runs) parts, so the resistance between each plate could be tailored to ensure symmetry and to get to a desired net toroidal resistance. This would enable decreasing resistivity between runs if we find we are struggling with vertical stability or increasing if we are struggling with start up.

A Recommendation noted and electrical strap was added to the design as a dedicated path for current flow.Strap material can be changed/design can be adjusted if required between runs.

CR-*VVHW*-2012 - *Vented hardware*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR05	Use vented hardware whenever bolting to a blank tapped hole

A Considered. None of the location requires vented hardware.

CR-*VVHW*-2013 - *Analysis model*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR12	stiffeners are fully bonded to the passive plates in the current analysis model. Need to reflect the actual bolting design for FDR

R See response Above for PASPLAPDR14

CR-*VVHW*-2014 - *Radiation shield on Passive Plate stiffeners*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 13	Consider adding a radiation shield to the PP and SPP stiffeners. The addition of the stiffeners potentially provides a platform to mount a radiation shield to improve bakeout performance.

O = Out of Scope. Per review board's comments at the PDR "out of scope for this review -- project decision -- instrumentation scope. Project Engineer(Y.Zhai) is in agreement with this resolution.

CR-*VVHW*-2015 - *Thermal gradient between vessel and welded wedges*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESC DR12	Evaluate the effect of electrical jumpers and welded wedges on thermal shorting of the 350C PP to the 150C vessel during bakeout

NA Welded wedges concept was abandoned at PDR

CR-*VVHW*-2016 - *Helium tube currents*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESC DR11	The helium line induced current is a strong function of the plate-to-plate resistance, and is apparently a non-monotonic function of the resistance. Need additional analysis to understand non-monotonic trend, and also widen (and probably refine) the range of the resistance values assessed to place bounds on the maximum helium line current.

A The non-monotonic behavior was found to be incorrect. As the resistance of the bracket was increased in the study the net tube resistance was inadvertently increased as well since tube was unintentionally in series with a portion of the bracket. When corrected, the PP curve was monotonic as the others were. A.Brooks

CR-*VVHW*-2017 - *Electrical isolation of clam-shell bracket*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 19	Should not have electrically floating clam-shells used to protect against bending of the He bake-out tubes. Need single-point grounding or perhaps a toroidal break in the middle and electrically connect half-clam-shell at each toroidal end. Anyway, need to ensure clam-shell is neither floating nor shorted toroidally.

NA Clam-shell concept is abandoned for FDR and fabrication.

CR-*VVHW*-2018 - *Fatigue life of Helium tube*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 17	Analysis has indicated that even the 0.6 MA*T operation of NSTX exceeded allowable stresses for the helium tubes in many cases. In particular the "large loop" pointed out by A. Brooks has the potential for extreme values of stress. The proposed design change of clam shell supports can change the stress distribution, but it should be verified that the previous stresses have not used up the fatigue life of these components and that the modified design avoids stressing the same locations.

A Visual examination of existing Helium Piping shows the pipes are indeed trapped by the surrounding PP support structures so have not experienced the large stresses reported.For existing life usage see report “NSTX-U recovery project Structural analysis report for Helium line bracket and Weld Evaluation NSTXU_1_1_1_2_1_CALC_054”.
-A.Brooks

CR-*VVHW*-2019 - *Magnetic damping*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESC DR08	I think that the magnetic damping calculation can only take credit for the toroidal field (?). Assess which field components provide the magnetic damping, and bracket the effect to those that can be assured to be on. Maybe also get the minimum toroidal field that could be run for 2 MA (0.8?), and use this to bound the magnitude of the magnetic damping

A During the disruption, poloidal fields from the plasma in P3, P4, and P5 positions will

ficant as well as the toroidal field. Background fields will also exist. These should be e included in the estimates of magnetic damping. See Magnetic Damping Calculation report NSTXU_1-1-1-2-1_CALC_100. From Figure 1, you can see we choose the lower bound of the magnetic field Bz, B toroidal is constant, Bz we used the least number from Art's disruption analysis, and give a conservative estimation of damping coefficient of ~15% for PPP and ~12% for SPP.Passive plate motion happens upon disruption load, and there must be some Bz during this plasma disruption process.- H.Zang

CR-*VVHW*-2020 - *External Biscuit counterbore*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESCDR01	External Biscuit - Consider counterboring the hole so that the screw head is partially buried. This will minimize bending in the screw, which is loaded in single shear, unlike the present version.

A Recommendation adopted in the design. See drawings E-DB1489 & E-DB1495

CR-*VVHW*-2021 - *Contacts in Analysis*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESCDR15	Modeling ext. biscuit with no separation is not conservative. Change contact to more realistic and re-evaluate.

A Analysis model updated with frictional contact. See report “NSTX-U recovery project Structural analysis report for Passive Plate additional support bracket, Stiffener NSTXU_1_1_1_2_1_CALC_052 - Wassee.

CR-*VVHW*-2022 - *External biscuit vs Wedge design option*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESCDR02	I recommend using the external biscuit design. It solves the existing problems better than the wedge design, because it removes the uncertainty in the load path through the existing biscuit.

A Recommendation adopted in the design. Wedge design abandoned.

CR-*VVHW*-2023 - *Match-drilling holes*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 10	The current design has match-drilling on the new biscuits so that a tight fit will exist. It is suggested to scribe or mark the biscuits so that they can be identified for specific locations in the machine. This is to aid re-assembly without further modification to the biscuits in the event this system is taken apart in the future.

A Recommendation adopted in the design. Each biscuit going out for match drilling will have location marked on it and will be traced with travelers. See drawing E-DB1489

CR-*VVHW*-2024 - *Passive Plate movement*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESC DR04	We know that the individual brackets can be moved by hand but the assembly is much stiffer with the passive plate bolted in place. Is there any evidence recorded, seen on video, heard banging...any recorded evidence that there has been motion during disruptions with the structure fully assembled? Where is this evidence? What is the force/moment needed to move the fully assembled plates and is this force/moment reached during operations?

NA Per review board's comments at the PDR "No New Action."

CR-*VVHW*-2025 - *Toroidal resistance*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESC DR06	Does toroidal asymmetry in resistances end up coupling vertical motion and n>0 modes? Should probably have some symmetry tolerance in the requirements.

A Abstractly, there likely is the coupling noted here. However, NSTX operated successfully with whatever degree of asymmetry was present in the absence of the electric straps. The straps are symmetric by design, and therefore can only improve the present situation. The alternative would be to measure the electrical conductivity of the multi-biscuit mounting scheme at *each* location, and adjust the electric strap accordingly. This would be cost and time prohibitive. For these reasons, the project adopted the scheme of identical electric straps everywhere.

R-*VVHW*-2026- *Procurement*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 04	Counterfeit/Suspect Item policy requires additional steps for use of high-strength components. Procurement schedule may be impacted if a qualified vendor of high-strength components is not available and these parts are needed & fit the criteria.

A Procurement has a list of qualified supplier for A1 components. It includes potential suppliers of high-strength fasteners for the Passive Plates.

CR-*VVHW*-2027 - *HP/Safety*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 06	Have VV activation evaluated with respect to welding and the need to avoid breathing activated metal vapor during welding process. Additional precautions may be needed including specialized welding helmet. (J. Bartzak did so on NB upgrade welding.)

A Reached out to HP regarding this. Below is a response from HP.

"Ankita;
We have no requirements in place for welding on the vacuum vessel in the areas you show below. Welding was routinely performed on the VV during the upgrade project. The only ventilation that was in place was due to the shop requirements for welding, not radiological. During the 2016 run campaign we did not produce enough high energy neutrons to create any appreciable long lived radionuclides and the short lived capture components have long since decayed away. As long as you are not welding on the RF antenna, feedthroughs or the components of beamline 2 that were on TFTR there will not be any HP requirements to weld. The ventilation in place for the upgrade welding was a requirement by IH to protect Joe and company from inhaling the welding fumes. I suspect the same local ventilation will also be in place for the same reasons.
George"

CR-*VVHW*-2028 - *HP time*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 23	HP costs to survey items going out and back into the VV will be charged to this job. Consider covering HP at some appropriate level. See Patti Bruno.

A Reached out to HP to get time estimates. Their response is included in BOE for Passive Plate WAF

CR-*VVHW*-2029 - *Electrical Strap/Shunt*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 07	Consider "sandwich" of SS-Cu-SS (or similar) with varied Cu thickness for electrical connector/strap to control resistance for physics and reduce over-compression/deformation of Cu-Cr-Zr under the nuts/bolt-heads at each end of the connector.

A This was considered and is part of the final design. The design is currently a sandwich of 4 layers of Cu-Cr-Zr. This design does not deform under bolting loads which were simulated. If required after initial operation, an additional layer of SS could be added to get whatever resistance is needed. But current design centers around design requirement of conductivity.

CR-*VVHW*-2030 - *Electrical strap design*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 22	Passive plates bracket jumper modifications shall not affect contact area between jumper and the bracket. The thinning of the jumper should be done in balance so thermal expansion does not add to the stress on the jumper.

A The design is currently 4 x 1/32” layers (⅛” total thick) Cu-Cr-Zr which allows successful flexure of the joint under loads, adequately performs wrt temperature, but remains intact. This was pursued instead of thinning as its a better compromise for flexure yet does not thin (which could turn the shunt into a fuse). Layers are spot welded together at either end to ensure complete bulk conductivity between layers. And this design change does not affect the contact area between the shunt and bracket. See calculations NSTXU_1_1_1_2_1_CALC_053 & drawing E-ED1479.

CR-*VVHW*-2031 - *Electrical Strap / Shunt Design*

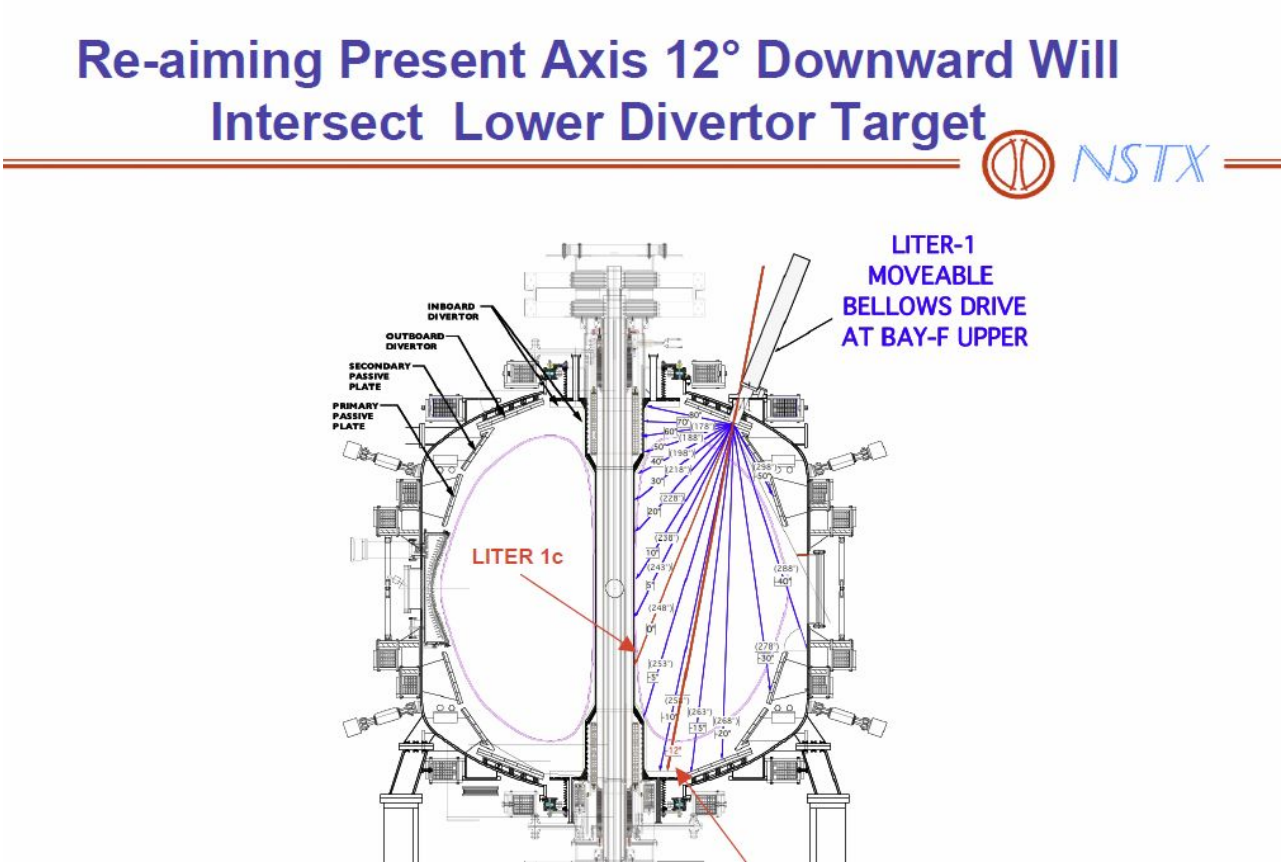
Review	ID	Chit
Passive Plate PDR	PASPLAPDR 18	Consider silver plating the end contacts of the passive plate jumpers. Also consider adding a stainless steel load distribution plate, which will provide more uniform contact pressure. See "Electric Contacts" by Ragnar Holm.

A Considered but not required (silver coated SS shunt). With the SS load distribution plate (part of current design), there is adequate contact between the strap and the bracket, see calculations NSTXU_1_1_1_2_1_CALC_053.

CR-*VVHW*-2032 - *Line of sight from LiTER probe*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 11	Determine if there are any direct lines of sight from LiTERs to resistive connectors/jumpers. May not be acceptable to have lithium directly depositing on thin copper strap - this could be another reason to protect copper with a parallel stainless layer.

A The drawings and FDR presentation for the LiTER probes reviewed. Copper brackets are behind the Passive plates and close to vacuum vessel wall, away from the LiTER's direct line of sight.See image below.



CR-*VVHW*-2033 - *Installation*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 08	consider optimizing the movement of parts in and out of the vessel to minimize HP time. If contamination is a concern, is there any benefit to setting up an area in the South High Bay??

A Acknowledged. There is no contamination issue for Passive Plates. See response from HP above in chit PASPLAPDR06

CR-*VVHW*-2034 - *Weld Inspection*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 20	Should perform inspections of bracket welds (and other welds) while passive plates are presently out of the machine.

A Inspection was completed by Neway at Passive Plate CDR. CAD and analysis models were updated with most conservative “As-built” changes to qualify the existing welds.Drawings E-DB1053, E-DB1055, E-DB1057, E-DB1059, E-DB1061, E-DB1065, E-DB1070 & E-DB1071 for as built model CAD model.

CR-*VVHW*-2035 - *Bolt fatigue*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 15	Assess fatigue for the 750MPa stress in the bolt that goes through the biscuit

A FDR analysis shows bolt stresses at biscuits is 483MPa and are within allowables for an Inconel 718 bolt. See FDR analysis report NSTXU_1_1_1_2_1_CALC_052 - Andrei.

CR-*VVHW*-2036 - *Fatigue life usage*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 16	Should consider fatigue life usage factor (from NSTX and NSTX-U) for parts of the bracket that were of concern in as-built design. The new design may show these areas survive more than enough cycles to meet GRD assuming starting from 0 cycles, but it may be necessary to get stresses at these locations even lower if a non-zero usage factor is considered.

A The contribution of the existing life usage - based on loading that is at most 25% of the recovery project loading - was found to be minimal since the effect is exponential. At 25% load, the life is more than 100 times that at peak life contributing less than 1% life usage from Miners rule.

CR-*VVHW*-2037 - *Toroidal resistance value*

Review	ID	Chit
Passive Plates & He Lines CDR	PPHELINESCDR05	Slide 9 of Stefan's presentation says not to significantly reduce the aggregate resistance from previous operations. Does this mean compared to previous NSTX-U operations or previous NSTX operations? Resistance also shouldn't be increased significantly or vertical stability will be harder. if NSTX-U values are really 5x more than NSTX (Stefan's comment), maybe we should try to get back to NSTX values?

A There were no changes in the plate design between NSTX and NSTX-U (except for some minor changes to the bolting). The resistance values for the plate circuits used in the physics operations models (LRDFIT) were the exact same for NSTX and NSTX-U, and these models recreated the transient currents of NSTX-U very accurately for calibration magnet pulses and breakdown. Hence, the 5x increase found during in-vessel measurements in 2018 should be treated with suspicion.

In any case, the proposed design will provide a modest perturbation, while also providing a symmeterizing contribution. Any design that attempts to reduce the bracket resistance by a factor of 5 would unwarranted by the existing data.- S.Gerhard

CR-*VVHW*-2038 - *Passive Plate fatigue life*

Review	ID	Chit
Vacuum Vessel & Internal Hardware DVVR	VVIHPP18	Were passive plates checked for fatigue life?

A Yes - See calculation number NSTXU-CALC-10-07 Section 8.1 . P.Titus

CR-*VVHW*-2039 - *Accelerometer installation*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR01	The presence of accelerometers has caused a lot of discussion. The language about their necessity or usage in the design review process needs clarification (especially for future reviews). The answers given during the review are that the loads used for design are conservative estimates. The accelerometers, if used, would only be used to VERIFY that the machine operates within the estimated quantities. If this verification step is absolutely necessary, the project needs to add a diagnostic and instrumentation task to make these measurements.

ccelerometers are installed on to the passive plate during upgrade. They will be wired during NSTX-U Recovery project. This is included in Diagnostic wiring layout See drawing E-ED1471. Feedthroughs are located at Bay L.

CR-*VVHW*-2040- *Accelerometer*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 02	Unclear whether plate-back accelerometers will be re-installed, whether they will be part of overall instrumentation plan, or if accelerometer data will be used and required to validate plate motion/distortion models prior to allowing machine to operate at full plasma performance up to 2MA, 1T. If the sensors are needed, need to include re-installation/reconnection scope, cost, and labor in passive plate WAF or instrumentation WAF.

R See resolution of previous chit PASPLAPDR01

CR-*VVHW*-2041 - *Accelerometer drawing*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 09	Assembly drawing needs to reflect what is actual on the floor. If a drawing shows a sensor mounted on the back side of the passive plate, then QC will look for that sensor during inspection. So if the sensor is not wanted it should be removed from assembly drawing.

A Drawings are updated to show Accelerometer see drawing E-DC1322 and E-DC1323.

CR-*VVHW*-2042 - *Installation sequence*

Review	ID	Chit
Passive Plate PDR	PASPLAPDR 24	Does the work in vessel need to be sequenced with the He bakeout feedthrough work. Is the feedthrough work a prerequisite.

A The feedthru work is not a prerequisite for He tube support.

CR-*VVHW*-2043 - *Helium tube wall thickness*

Review	ID	Chit
Passive Plate PDR	PFCDIAGFDR01	Should measure wall thickness of He bake-out tubing if at all possible (using UT?) to verify models are using correct wall thickness.

A In-vessel inspections are completed per IP-D-NXTX-4029. Analysis models are updated with correct wall thickness.

CR-*VVHW*-2044 - *Additional thermocouple*

Review	ID	Chit
PFC Diagnostics FDR	PASPLAPDR24	Please consider including review of additional / new thermal couples added onto the passive plate into the passive plate FDR

A Agreed. Thermocouple locations were evaluated and revised during the course of the final design of the Plasma Facing Component Diagnostics. These locations are shown on drawing E-ED1471. The isolating thermocouple cover will have the same dimensions as the one on the existing thermocouples, so the tile design is not affected. Thermocouple assembly E-9D11554-01 fits..The PFC Diagnostics and Fueling Requirements Document was revised in February 2019 to reflect the updated locations of diagnostic sensors in the passive plates.

CR-*VVHW*-2045 - *Add Belleville washer*

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR01	To bolt stiffener to passive plate, add proper bevel washers according to the bolt load to prevent bolt loosening during operation.

A Due to space constraints belleville washers can not be added under the bolt BUT Spiralock threads will be added as an alternate design serving the same purpose. See drawing number E-DB1508

CR-*VVHW*-2046 - *Add electrical insulation specification*

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR02	The clamp/grafoil/anodized insulation system has to withstand a voltage due to eddy currents so consider checking on the amount of voltage developed and verify that the insulation is adequate.

A 0.005” of Al2O3 coating will be applied on all surfaces that captures grafoil in Helium Tube bracket. See drawing E-DB1509.

CR-*VVHW*-2047 - *Prototype Grafoil installation*

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR03	Consider prototyping/verifying the assembly and performance of the Grafoil tape/tube interface. Prototyping/bench testing may address the concern that the Grafoil may telescope or be structurally degraded during the axial thermal displacement of the tube due to the unconfined outer surface of the Grafoil.

A Prototype was done. Parts were made and put into the oven for 3 bakeout cycle to check the outgassing as well as test Fortafix as the bonding agent for grafoil tape. The Fortafix is qualified for 750 C and didn’t gave up during the testing. The tube was free to slide through the grafoil bushing and the tape did not telescope out. This will be incorporated into installation procedures.

CR-*VVHW*-2048 - *Helium tube support bracket*

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR04	Bracket for helium tubes as designed requires custom fit. If the bracket is designed in two parts, one tab welded on the vessel and another part with clamp, bolted to each other. It decouples the welding and assembly.

A Due to space constraints in the vessel,this design cannot be adopted for helium tube support bracket.

CR-*VVHW*-2049 - *Calculation Signature*

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR05	The approved Design Review Plan (NSTX-U_1-1-1-2-1_DRP_100) lists 6 calculations for this DR. Only 4 are posted. Among these 4, the signatures are either incomplete or misplaced. The signature requirements are as follows: Calculation Form (COG, Preparer, Checker); Checking Form (TA, with the Checker named - no checker signature). Refer to ENG-033 Attachments 2 & 3 for signature and content requirements.

A All reports are now signed and filed in the document management system.

CR-*VVHW*-2050 - *Installation gap*

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR06	If the bottom surface of the biscuit is the load pass, then the top mating surface should be allowed a 0.005" gap to ensure the bottom contact and easier installation.

A Recommendation adopted in the design. See the assembly drawing E-DB1495 for the changes.

CR-*VVHW*-2051 - Drawing update

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR07	Ensure stiffener bolt size of 7/16" is reflected in design documentation and drawings.

A Drawing is updated. See drawing E-DB1322 and E-DB1323.

CR-*VVHW*-2052 - Drawing update

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR08	The analysis indicated that the stiffener bolts were required to be increased to 7/16" - 20 inconel. Insure this is incorporated into the design.

R Duplicate chit. See chit response CR-VVHW-2051

CR-*VVHW*- 2053 - Fatigue Life

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR09	Please check with Stefan fatigue shot spectrum the total number of disruptions required to qualify the fatigue life for the Passive Plate analysis.

A

CR-*VVHW*- 2054 - Drawing update -Material

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR10	The support biscuit material change in the analysis to go to 718 needs to be incorporated into design documentation and drawings.

A Drawings updated with changes. See drawing EDB1489.

CR-*VVHW*- 2055 - Silver plate fasteners

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR11	Recommend silver plating stiffener bolts (and any other threaded fasteners) in-vessel.

A. Stiffener bolts are Inconel 718 while Stiffners are 316SS. The hardness of the Inconel 718 reduces the risk of galling. Silver plating of the bolt adds up the cost and schedule time and doesn't add up the value.

CR-*VVHW*- 2056 - Vacuum Prep

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR12	All vacuum components need to go through vacuum preparation according to OP-VV-175 (PREPARATION OF COMPONENTS FOR NSTX-U VACUUM APPLICATIONS) before installation

A Already in the WAF.

CR-*VVHW*- 2057 - Weld increases.

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR13	Add VV weld increases per Brooks analysis to design documentation, drawings, and BCP to add this activity.

A Welds are qualified with a dedicated weld analysis with Post FDR values. See calculation report NSTXU_1_1_1_2_1_CALC_054. No need to increase existing welds.

CR-*VVHW*- 2058 - Electrical Strap

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR14	Requirement for accuracy of strap tuning was not clear. It is necessary to finalize the geometry and trimming method

NA Per review board's comments, It's outside the scope of this review.

CR-*VVHW*- 2059- Worst Disruption Load Case

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR15	Some drift and disruption analysis has been based on a rendering of the GRD shot spectrum, RD-03, and input from Physics regarding disruption type selection and shot numbers. P4 and P5 and 1500 cycles were used. Additionally, using P3 was newly suggested at this review. Review the selection of the requirements, disruption P type selection, and total cycles used to ensure that the design is validated and documented to these requirements.

A See calculation report NSTXU_1-1-1-2-1_CALC_104 for P3 vs P5 disruption loads and shot spectrum number selection for Passive Plate design.

CR-*VVHW*- 2060 - Self Field induced by 210 kA current

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR16	The self-field produced by the 210 kA current flowing in the electric strap should be taken into account as external field in the load assessment.

A A re-run of analysis was performed with self-field and the electrical strap was found to meet the requirements. See Appendix in calculation report NSTXU_1_1_1_2_1 CALC 053

CR-*VVHW*- 2061 - Vacuum Prep

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR17	New toroidal restrictors create additional current pass. Especially the one in the corner of the primary plate where passive plate bracket is clamped between two restrictors, and pre-tensioned by the biscuit bolt. This also restricts the movement of the passive plate in poloidal direction due to friction. This needs to be accessed.

A Toroidal restrictors will be coated with Alumina. For concerns related to restricting poloidal movement of passive plate toroidal blocks will be installed first with gap of at least .005”

CR-*VVHW*- 2062 - FMECA

Review	ID	Chit
Passive Plate FDR	PPHeTube FDR18	FMECA mitigation (including this scope and but beyond as well) will also need to include maintenance and inspections when machine accessibility permits in conjunction with information gained from machine instrumentation.

A Not in the scope of Passive Plate it applies to Project wide FMECA document.