DESIGN REVIEW DOCUMENTATION – RESULTS

Title: **NSTX-U Repair – CDR** _____ **WP#:** 2254 (ENG-032)

Type of Review: ☐ **Peer** ☒ **CDR** ☐ **PDR** ☐ **FDR**

Cog Individual: **Charlie Neumeyer** _____ **Date of Review:** **8/1-2-3/17** _____

Review Board Members:	**Invited attendees :**	**Contributors and Observers:**
Chairperson V Riccardo	G Ascione	R Burke
R. Bamber	B Blanchard	D Cai
B Beck	J Dellas	C Ciummo
M. Cox	B Ellis	A Jariwala
L Dudek	S Gerhardt	A Khodak
R Haange	R Hawryluk	B Linn
M Huguet	F Hoffman	W Que
A Kellman	M Kalish	M Smith
D Kellman	D Loesser	Y Zhai
J Levine	M Mardenfeld	T Brog
F Malinowski	J Menard	L Hill
R Parker	C Neumeyer	D Knutson
T Todd	E Perry	S Langish
R Vieira	J Petrella	M Zarnstorff
C Vorpahl	S Raftopoulos	D McComas
D Youchison	H Schneider	C Reno
	M Sibilia	S Weidner
	T Stevenson	J King
	G Tchilinguirian	A Indelicato
	P Titus	P Johnson
	A von Halle	M Lanctot
	M Reinke	S Rogan

Items Reviewed:	**Sat.**	**Unsat.**	**Comments or n/a if not applicable**
Appropriate requirements identified	☒	☐	
Development plans and schedules	☐	☐	N/A – cost and schedule review 9/6-8/17
Regulatory compliance including USI/USID and NEPA	☐	☐	
Disposition of CHITS from previous reviews	☒	☐	
Cost objectives	☐	☐	N/A – cost and schedule review 9/6-8/17
Other review objectives addressed (Attachment 4 of ENG-033)	☒	☐	

SUMMARY OF RESULTS:

Presentations and supporting material can be found on the CDR dashboard: https://sites.google.com/pppl.gov/CDR/home

In the Introduction as well as listing the areas of the project covered by the CDR, it was explained that the focus of the CDR is on the technical scope, in preparation for the Cost and Schedule review on September 6-8. The objective is to have a single design path in all areas, which will be costed. If this is not achieved, the cost will be bracketed by the alternatives.

Inner PF Magnets

During the main session, the manufacturing strategy was discussed in detail. All vendors and PPPL need to qualify using the PF1A design, as this is more challenging than the others; the rational for this was accepted. Vendors are allowed to produce a prototype with either 101K or 425 epoxy systems, however PF1B will use 425 and require qualification with that epoxy. The aim is to procure three sets of pairs of coils in parallel. There are concerns that the teams used for the qualification at the vendors are more experienced that the teams used in the production. While the team selection at the vendors cannot be ensured, although the ability to influence it is part of the selection process, on-site supervision will be significantly stronger than it had been with the first set of Inner PF coils.
The definition of the coil cross section and position has practically converged and satisfies the updated performance requirements. Joggles are confirmed removed in PF1A (not needed in the others).
For all PF1 coils, the winding pack conceptual design appears to be sound and robust. The use of a copper conductor without any internal brazed joints virtually eliminates the risk of internal water leaks. The turn and ground insulations are conservatively designed with redundant layers of glass and kapton which provide a high safety margin with regards to voltage standoff requirements. Importantly, this insulation provides also robustness against manufacturing risks linked for example to the possible presence of imbedded metal debris or to mechanical damage which may occur during winding or coil handling.
The insulation remains potentially vulnerable at the coil terminals. Continuity of the insulation is essential to ensure that no crack develops at the re-entrant corner where the terminal insulation and the winding pack insulation meet. Such cracks would provide a short creepage path to the inside the winding pack. In presence of humidity, this could result in a short circuit. Michele Huguet suggested adding a sock around the terminations. Useful remarks were made on the dipole minimization at the conductor tail transition and on the risks of embedding diagnostics. The insulation voltage stand off has a very large margin with respect to power supply voltage, however the voltage induced by other coils still needs to be combined. The need to test samples with different levels of delamination at the kapton was discussed.
With the new performance requirements the stresses in the inner PF coils easy fit within their allowable. The proposed coil support concepts appear to be feasible and to fulfil design requirements. Other design options, such as using thin integral toroidal cans (as proposed for PF1C) for all PF1 coils instead of “sling” supports, may be feasible but have not been evaluated. It is, however, recommended to concentrate on the proposed concepts, i.e. slings supports for PF1A & B which minimizes toroidally continuous structures. With the new layout in the PF1B region, bakeout of the tiles at 350C is possible without negative effects on the coil. Improvements to the magnet supports were suggested: fiberslip to minimize friction and remove redundant contact to the outer side of the PF1C coil, as the centering action is taken by the radial groves on one of the horizontal faces.

In the breakout session, presentations were made on the preparation of a straight bundle to test material compatibility and VPI technique, on the design of tooling and VPI mold for the PPPL winding activity, status of the PPPL winding facility, simulation modeling related to turn-to-turn electrical testing, and finally on plans for electrical testing. Significant progress was evident in the understanding of the turn-to-turn testing issues and comparison of methods, including concept for split core testing that was recommended by the EoC committee. The down-selection between surge testing versus split core testing is needed very soon to allow enough time for testing systems to be mobilized. This will be particularly challenging for the split core testing since the system has to be custom designed and fabricated.
The general impression is that the preparation for the manufacture of the PF1A coil prototype is progressing well and that all important technical issues are being addressed in a professional manner.

Polar Region

The progress with design was well received. The simple way thermal insulation is achieved between the divertor flange and the PF1B coil was praised. The casing vertical support (in place of the magnet mandrel) was discussed, an initial project decision was taken to route it outboard of the PF1B coil. Although this sacrifices the direct vertical load path, it preserves magnet volume as the thermal expansion clearance does not have to be accommodated. In one area, the design has not settled – use of either bolting or welding to affix the casing support structure to the casing itself. A potential weak weld at the transition sleeve to flange weld was identified, and a reinforcement method with a gusset structure was identified and described. The lateral load capability of the G7-SS interfaces at the insulator was questioned, as was the lateral load capability of the SS-SS interface on the vessel which is loaded with only 18 bolts. The use of pins to replace or supplement friction in these regions was recommended

Seal designs with both welded seals and with double O-rings were shown, and the use of double O-rings was accepted for the base design. In some locations pumping could be challenging due to the small interspace and the level of vacuum reached could be at the Paschen breakdown minimum. Questions were raised on the maximum temperature allowed for Viton rings, and the maximum allowable temperature in the requirements will be reduced accordingly. The use of alternative materials for ceramic insulators was discussed; no manufacturer appears to be able to form a Zirconia part of the required size, and BN is viewed as having insufficient strength. Therefore, the previously designed Al_2O_3 rings appear to remain the primary option. The lateral loads from the casing are proposed to be supported by new radius rods. Whilst this solution seems feasible, it is noted that the design team appeared to encounter many packaging issues with this design and the panel asked about the possibility of incorporating features into the flanges to solve this issue. Peter Titus discussed the load reaction from the center casing and suggested that a gusset plate should be introduced to help remove the load from the vacuum weld.

For heating and cooling of the horizontal divertor plate, a clear preference was expressed for an additional segmented plate with coaxial inlet/outlet to provide also a new bolting interface for the IBDH tiles. In-vessel helium cooling needs further assessment as the plant is normally not run continuously. This may have an impact on the cooling of the OBDH and the passive plates as well.

The breakout session was attended by a small number of engineers, where these issues noted above were discussed in detail. Chits from the April Design Integration Review were also discussed, where it was determined that only polar region chits 23 and 44 from that review have not been addressed in the present design; note that it is expected that these will be resolved by PDR.

Plasma Facing Components

Significant progress was made in the definition of the exhaust heat loads and the halo current loads. This resulted in the need to re-assess all the tile designs for thermal and electromechanical compatibility. Tile types were grouped in three classes: passed by analysis (CSFW – pending tests on the pins connecting floating columns to bolted columns), in need of modest improvements (minor design changes, new components: CSAS and OBD3-5) and new concepts (IBDV, IBDH and OBD1-2). The level of confidence in the design and assessment of CSFW is high: ideally a slightly modified design making use of the existing components will be qualified by analysis and testing, if not minor improvements not requiring the replacement of the tiles have been devised. The level of maturity of the modest improvement designs is also good. The new concepts are instead not ready: one has reached good design and analysis maturity, but concerns exist regarding the cost and schedule associated with assembly and installation; its alternative, driven by a chit at the Polar Region Integration Review, is far less advanced and does not have a track record in any fusion device, but it offers simplicity for the assembly and installation. A third concept has been developed for the other high heat flux region (OBD1-2) and this too is at a very early stage. As the designs have not settled yet and further details on the poloidal heat load distribution have become available, pointing out that the areas closest to the corner between the vertical and the horizontal section are less loaded, the designers have been invited to investigate ways to install tiles without plasma facing holes, using the low power density areas for access. The definition of allowable stresses for brittle materials under tension remains an open issue, as is the specification of tests to establish the allowable stresses (statistical nature, cyclic effects…). Independently from the choice of design, the interface between the outer edge of the IBDH and the inner edge of the OBD1 needs special attention, due to the relative movement of their two supporting structures, the exposed poloidal extent could be large enough to require shadowing, while the poloidal angle of incidence can point inward or outward.

In the breakout session, besides running through the resolution, or progress towards resolution, of the chits from the Polar Region Integration Review, the discussion was focused on the two designs for the IBDV and IBDH high heat flow regions: floating cubes and castellated graphite. The recommendation is to advance the design and analysis of the castellated graphite concept, while carrying out basic mechanical tests (4 point bending, simulating disruption net forces and torques) on representative samples to observe the effects of a complex stress field with the singularities. High heat flux tests need to be planned for the selected and the backup concept. Selection criteria need to be developed (e.g. compatibility with high heat loads in one direction and modest heat loads in the opposite direction, compatibility with diagnostics…) to be combined with cost and schedule considerations. It was also recommended to try and focus on one design, not three for the high heat flux region.

Bakeout

The consistency between the GRD and the SAD requirements was discussed. The rationale for 150C limit on the outer shell is needed.

It was agreed that the Medium Temperature Water system needs to conform to industry standards. A plan is in place to address the safety concerns on the High Temperature Helium system, including steps such as reducing the volume of the system by eliminating the expansion tank and improvements in the interlocks.

Numerous improvements were described for the hot He system. To help balance the top and bottom helium flow, metering valves will be added to the new feedthroughs (which are introduced as part of addressing the safety chits from the DVVR), as well as moving the NB loop from the top to the bottom manifold. Flow and temperature measuring valves will be installed in a

number of locations to better understand the behavior of the system. To improve the vessel heating provided by the helium system, radiation shields could be installed between the passive plates and the vessel; this solution still needs significant analysis before the PDR. A design was presented using dual reentrant feedthroughs to replace the present machine feedthroughs, which were shown to have unacceptable thermal stresses. The insulation on the piping conveying the hot He will be replaced, and an e-stop will be provided outside the exclusion zone around the blower/heater skid.

Finally, in order to allow DC bakeout with a single, top, ceramic break, the power supplies and feeder conductors need relocated. A design for permanent installation of the power supplies and re-use of the existing bakeout cabling was discussed.

In the breakout session, the cooling requirements for the OBD were identified as needing better definition. This has potential implications for helium cooling system that needs to be resolved by the PDR.

Instrumentation

Enhance machine instrumentation is needed to benchmark the models and assess the coil and structure performance and to detect possible degradation of machine performance. The emphasis is to detect degradation at the outset before potential damage to machine components. The scope is well defined in a requirements document. There was a minor discussion regarding the sampling rate, which should be clarified but the system is capable of meeting the requirements.

During the breakout session, the ability to calculate global results such as torque on the TF bundle from a limited number of sensors including the noise on the sensors was identified as requiring further analysis. This is a classic inverse problem, which should be considered. In addition, AUG employs a different approach regarding mounting the sensors by welding them to a plate and spot welding the plate on the structure. We should examine this approach especially for new components under design.

Test Cell Shielding

Neutron generator measurements identified areas requiring additional shielding. The 10 primary areas of interest are (in order of severity) are:

South East door. Entrance to the NSTX High Bay
South High Bay Tritium Seal Door
North NSTX-U test cell door vestibule
Lower large window, North East corner
6” Penetration adjacent to South East NSTX High Bay Door
10” Penetration in mezzanine laser room
Three cable penetrations east wall north
RF Feed thru Penetrations at 119’ level
Bake out Penetrations in floor to MER
NB Water Penetration in floor to MER

The scope is well defined.

Conclusion

The CDR was well prepared. The recommendations from the Extent of Condition Report were embraced in both suggested new requirements and basic design philosophy. The high priority chits from the DVVRs have a plan to be addressed and in some case fairly developed designs too. In most areas designs are mature enough for a CDR, or even more. Down-selection is still not possible in a very small number of concepts, of which the only one that could be a substantial cost and risk driver is the high heat flux region of the divertor.

Disposition: [check one]

_____ **Acceptable**

x_____ **Acceptable pending resolution of concerns**- CHITS identified above must be resolved prior to installation.

_____ **Incomplete -** Additional design work is required prior to another design review.

_____ **Unsuccessful** – Corrective actions must be taken and another review process must be initiated.

RLM Concurrence: Charles L. Neumeyer Digitally signed by Charles L. Neumeyer DN: cn=Charles L. Neumeyer, o=PPPL, ou, email=neumeyer@pppl.gov, c=US Date: 2017.08.13 13:40:11 -04'00' Date: _____

DR Chairperson Signature: Valeria Riccardo Digitally signed by Valeria Riccardo DN: cn=Valeria Riccardo, o, ou, email=vriccard@pppl.gov, c=US Date: 2017.08.13 14:36:05 -04'00' Date: _____

Distribution: Review Board Members, Operations Center, Cognizant Design Engineer, System Engineer(s), Head, Office of Project Management, Attendees, QA, ES&H, Security, Requesting & Performing Dept. Heads, and Associate Director for Engineering and Infrastructure

	Time stamp	Applicable Area		Submitted by:	Initial Comment	Responsible	Post-review comment
CDR1	8/1/2017 16:22:08	Bakeout System	There are reliability concerns about using the helium bakeout system during normal operations to provide "room temperature" helium for cooling purposes. A stand alone system has been proposed for the IBD-H cooling helium, but if additional cooling power circulating through the Passive Plates or Outboard Divertor is necessary, it could be problematic. The IBD-H helium and IBD-V (air side) water cooling removes approximately 70% of the heat content per shot. Need to assess, as an integrated system, whether additional cooling is necessary, or passive mechanisms like convection to the test cell air are sufficient to avoid unacceptable thermal ratcheting of the entire machine throughout the day. If additional coulding is necessary, assess the pros/cons of using the helium bakeout system vs some alternative like water through the air side tubes welded on the outside of the vessel.	M. Mardenfeld for group	concur	P. Titus	Check need for active cooling. Need single "whole" model. If needed, cool in-vessel with helium or the vessel shell with water?
CDR2	8/2/2017 13:56:29	Bakeout System	Need to assess why there is a 150 limit in the Safety Certificate. What safety issue are we addressing? Having it be a limit is fine, but safety?	Stefan Gerhardt	should assess	von Halle	Investigate why there.
CDR3	8/2/2017 13:58:25	Bakeout System	Consider using average and local peak temperature limits for external vacuum vessel during bakeout	danny cai	will assess impacts of various choices	Petrella	Depends on what we are protecting or monitoring. Select what needs to be protected and monitor suitably. Also monitir critical differential temperature for stresses and strains, one more type of location to be listed.
CDR4	8/2/2017 14:05:11	Bakeout System	Review the 150C maximum temperature listed as part of the Safety Certificate. Why is 150 C chosen and is it really an operational goal and not safety related? It was stated that the 150C is an average temperature and not a local maximum. If so, this should be stated. If there are concerns about local vessel temperatures above 150C, then this should	Arnie Kellman	This combines previous 2 chits...	see above	copy

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			be stated separately and it should be determined if it is safety or operational.				
CDR5	8/2/2017 14:30:31	Bakeout System	Balancing hot-helium gas flows: I think it would be more appropriate to balance the outlet temperatures rather than the flow rates in the different paths. Joe told us that the intended flow meter also measure temperature, so make sure they are in the outlets of the branches, not the inlets (or else both, if you can afford it).	Tom Todd	seems right, should assess	Petrella	Agreed
CDR6	8/2/2017 14:34:47	Bakeout System	When looking at flow rates, or designing the # of throttling valves and flow measurements, please incorporate the need to feed He to the horizontal target heating/cooling features. This will change flow, and may be a degree of freedom for optimization???	Stefan Gerhardt	concur	Petrella	Agreed
CDR7	8/2/2017 14:38:44	Bakeout System	analyze how the added radiation shield for helping baking will affect heat removal during operation	danny cai	concur	Titus	related to "whole" model above
CDR8	8/2/2017 15:02:54	Bakeout System	RE: Radiation Shields on the Passive Plates. The passive plates have significant mechanical loads. Structural improvements, including Inconel bolts and Inconel shear bushings were required for the NSTX-U Upgrade Project. The proposed standoffs to reduce thermal conduction could be problematic....	M. Mardenfeld	concur. Will assess	Titus	Shield a good idea, different ways of implementing them are being considered
CDR9	8/2/2017 15:27:08	Bakeout System	When inspecting the inside of the water pipe and / or replacing sections need to consider required corrosion allowances for water. The original Dowtherm skid was designed and built for oil and may not have wall thicknesses required for water.	L. Dudek	Will inspect as part of the presently defined work scope	Petrella	Workpackaged being developed for C&S
CDR10	8/2/2017 16:14:24	Bakeout System	Should inspect the SS portions of the cooling water system on the VV. There may be sediment from corrosion products in the CS sections that can cause flow restrictions.	L. Dudek	SS tubing was OK during Upgrade time. Manifolds shoudl be assessed	Petrella	Copy
CDR11	7/21/2017 9:15:23	Inner PF Coils	Test	Langish			
CDR12	8/1/2017 10:10:31	Inner PF Coils	The weak spots, as far as insulation is concerned, are where the terminals penetrate the ground insulation. Continuity of insulation between penetrations and ground wrap is essential to avoid	HUGUET Michel	Will be addressed as part of the PDR and	M. Kalish	This is being considered

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			cracks developing at those pénétrations with the risk of humidity ingress. Glass and if possible kapton tapes must be laid to follow the reentrant corner where the terminals emerge from the ground wrap. In addition, ground insulation that is applied on terminals outside the coil must extend inside the ground wrap for some distance, say 5 cm, and be progressively reduced to the turn insulation.		manufacuring plans		
CDR13	8/1/2017 10:20:49	Inner PF Coils	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.	HUGUET Michel	Coil spec has requirements for cleaning the FRP. Larger concern has historically been adhesion to Cu. Will assess as part of PDR.	S. Raftopoulos	analysis (not relying on bond between leads and body) to determine if there is margin enough not to need tests
CDR14	8/1/2017 10:33:24	Inner PF Coils	Confirm that the water circuit of each coil shall be subjected to a pressure test after winding but before impregnation.	HUGUET Michel	This is planned	S. Raftopoulos	use a gas (e.g. helium) instead - OK
CDR15	8/1/2017 10:55:16	Inner PF Coils	Maximum turn to turn, layer to layer and coil to ground voltages can depend on coupling from other coils and plasma as well as the applied coil voltage. The resulting voltages depend on operating scenarios and the net effect may well be small but should be evaluated.	Ron Parker	Concur	C. Neumeyer	Agreed
CDR16	8/1/2017 10:58:48	Inner PF Coils	Coils typically delaminate locally. Is this expected for the PF1 coils? If so, where is the expected parting plane? Has the design of the interleaved layers of kapton and fiberglass (and priming if applicable) considered this?	M. Mardenfeld	Use of a previously qualified glass/kapton/resin scheme qualifies the system	S. Raftopoulos	With the Kapton layer it will delaminate - addressed in the design, additionally a dry test on a sample, depending on environmental conditions
CDR17	8/1/2017 11:10:57	Inner PF Coils	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	Tom Todd	Looking at historical data. The sense is that there is not a long term	J. Petrella	Document in memo, by JP

	Time stamp	Applicable Area		Submitted by:	Initial Comment	Responsible	Post-review comment
			continuously?		degredation		
CDR18	8/1/2017 11:34:57	Inner PF Coils	Test	Neumeyer			
CDR19	8/1/2017 11:38:48	Inner PF Coils	Investigate possibility of toroidal breaks in coil support flanges. Perhaps a temporary part can be used to hold the pieces together when assembling on a coil.	Neumeyer	Will consider going into PDR	M. Sibilia	It would not behave as a structural ring, but culd have a alumina coated lap joint - too complex to pursue ... use materal with higher resistivity
CDR20	8/1/2017 11:41:18	Inner PF Coils	test	Langish			
CDR21	8/1/2017 11:46:53	Inner PF Coils	PF1 A/B Support Slings: Deviations from perfect concentric alignment of coils with respect to each other will create sideloads on the PF1 coil bodies. Since the coil/sling is only constrained at on end, these will be reacted as torsion about a horizontal axis (which reacts as a couple increase clamping force against the sliding surface?). The sliding/flexing support mechanism must function properly and be stable against expected and self reinforcing pertubations from idealized concentricity during actual installation.	M. Mardenfeld	Is part of the design process that is present going on	P. Titus	Document that it has been addressed
CDR22	8/1/2017 11:50:40	Inner PF Coils	A chit to group/merge with others from MC and MH! I agree with Martin that the PF1C coils will be much stiffer than the slings/cans and therefore can be relied upon to centre themselves if the top and bottom radial guides are adequate. So a) you don't need the feebly competing G10 and sling/can distortion to recentre the coils and b) if the coils reliably recentre themselves, and the slings/cans are intrinsically centred, there will be no lateral force trying to produce the distorting stick-slide of the slings/cans that Michel was concerned about.	Tom Todd	It is likely that radial guides are a better solution, and this will be assessed going forward.	M. Sibilia	Will assess whether radial slides of outer ring for PDR
CDR23	8/1/2017 12:02:37	Inner PF Coils	The edges of the sling supports should be shaped such that they do not cut into or chaff the surface of the coils during thermal expansion or coil pulsing.	L. Dudek	Concur	M. Sibilia	OK
CDR24	8/1/2017 12:12:31	Inner PF Coils	Indefinite deferment of CHI does not mean elimination of CHI in the design criteria for NSTX-U. (An optimist would hope that with	Dennis Mueller	out of immediate	J. Menard	Keep CHI features where they do not

	Time stamp	Applicable Area		Submitted by:	Initial Comment	Responsible	Post-review comment
			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		scope for this review		present an increase in risk or cost

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			evidence of Li or of tracking.				
CDR25	8/1/2017 12:17:20	Inner PF Coils	I am suggesting thinking of Ultrasonic Vacuum Pressure Impregnation (U-VPI). Since the microstructure between the turns of the coil is very complex. Only the pressure difference (with vacuum) could be not sufficient. Because the max difference is only 14.5 psi, plus the viscous epoxy, large amounts of micro-air and water vapor bulbs would be still trapped in the microstructure and fibers. The additional force with interruption is necessary to involve thus assist the micro-air to dissipate from the fibers, also to help clean micro-solid particles, prior to solidification.	Feng Cai	Will assess	S. Raftopoulos	Not part of the coil manufacturers' standard procedures, although a good suggestion it will require too much effort to implement
CDR26	8/1/2017 12:30:21	Inner PF Coils	More on PF1C recentering by loading the outer skin of the can. Peter showed considerable high stress problems there, raising discussion about profiling the contact block to reduce the peak stress. I believe it was later agreed that all this goes away if the radial guides do all the work! Just keep a good clearance to let the coil expand.	Tom Todd	See row 14 chit response	M. Sibilia	copy
CDR27	8/1/2017 12:52:23	Inner PF Coils	Loooong ago I worked on the Culham Superconducting Levitron (similar to FM-1) and had cause to calculate the forces on the ring when it was displaced in the toroidal field. The result was a strong lateral force along the x-axis if the ring was tilted about the x-axis, and a strong torque about the x-axis if the ring was displaced (translated) along the x-axis. Please check the forces arising from putative coil misalignment wrt the TF, to be compared to those resulting from misalignment wrt the OH solenoid.	Tom Todd	Will assess	P. Titus	Loads being assessed, revised requirement on alignment might come from this
CDR28	8/1/2017 13:37:35	Inner PF Coils	Check stresses in insulation around coil terminals when terminals are slightly flexed to accomodate coil radial motion	Huguet Michel	Will assess (concern is mechanical stress on the insulation, leading to cracks)	P. Titus	It's going to be confirmed in the analysis
CDR29	8/1/2017 13:41:29	Inner PF Coils	Consider use of Fibreslip (glass - teflon woven material) as low friction interface for coil supports. Experience is available at JET: very low friction	Huguet Michel	will consider	M. Smith	working on it

	Time stamp	Applicable Area		Submitted by:	Initial Comment	Responsible	Post-review comment
			coefficient (<< 0.1), long life (44 years at JET), easily bonded to glass époxy insulation (JET TF coil noses and OH coil outer surface are covered with fibreslip sheets).				
CDR30	8/1/2017 16:33:40	Inner PF Coils	Consider the use of a load cell under the washers to be used on the preload for the vertical preload bolts.	Arnie Kellman	will assess as part of PDR	M. Sibilia	as needed, to be assessed
CDR31	8/2/2017 9:42:36	Inner PF Coils	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.	Tchilinguirian	A vendor of optical systems has been contacted and did an on-site visit; they showed ability to detect small debris in the co-wound insulation. Will follow up.	J Petrella	Optical systems to identify defects on tapes being investigated.
CDR32	8/3/2017 9:10:54	Inner PF Coils	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.	Neumeyer		R. Burke	Document that done
CDR33	8/3/2017 9:12:39	Inner PF Coils	Include features that facilitate the removal of the wedges so that there is no chance that the wedges get stuck.	Neumeyer		R. Burke	Document that done
CDR34	8/3/2017 9:22:03	Inner PF Coils	Consider potting the lead block volume with RTV pre-VPI to avoid resin-rich volume and facilitate post-VPI cleanup.	Neumeyer		L. Dudek	will consider
CDR35	8/3/2017 9:32:28	Inner PF Coils	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.	Tom Todd		S. Raftopoulos	This will be considered in the detailed definition of the winding procedure for the PDR
CDR36	8/3/2017	Inner PF Coils	Evaluate and implement best method to protect	Mike Kalish		L. Dudek	concur

	Time stamp	Applicable Area		Submitted by:	Initial Comment	Responsible	Post-review comment
	9:43:36		taping station from contamination.				
CDR37	8/3/2017 9:45:47	Inner PF Coils	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.	Huguet Michel			copy of CDR35
CDR38	8/3/2017 10:44:20	Inner PF Coils	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).	Huguet Michel		C Neumeyer	Document why this will increase risk
CDR39	8/3/2017 10:47:50	Inner PF Coils	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.	Frank Malinowski		C Neumeyer	need to develop tests and acceptance criteria, the ability to measure and additional risk will determine what will be progressed
CDR40	8/3/2017 11:01:41	Inner PF Coils	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.	Huguet Michel		M. Kalish	will consider for PDR
CDR41	8/3/2017 11:29:11	Inner PF Coils	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.	Tom Todd		C Neumeyer	Too difficult to distinguish from background

	Time stamp	Applicable Area		Submitted by:	Initial Comment	Responsible	Post-review comment
CDR42	8/3/2017 13:32:52	Inner PF Coils	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.	Jiarong Fang		S. Ratopolous	Email to expert to check whether temperature of test is relevant
CDR43	8/7/2017 8:56:46	Inner PF Coils	Use continuous cylinder on outer VPI mold, rather than clam-shell	Neumeyer		R Burke	Document resolution
CDR44	8/7/2017 8:58:19	Inner PF Coils	Employ Convectron gauges in place of Borden gauges for increased accuracy	Neumeyer		L Dudek	verify that there
CDR45	8/2/2017 11:25:52	Machine Instrumentation	The EoC2 report states: "The Digital Coil Protection System should be complemented with a system ensuring that an impending coil fault (in any magnet) can be detected well before more severe damage is inflicted on other parts of the machine by a major coil failure. This may require some additional sensors, or perhaps just a real-time or inter-shot implementation of the same type of magnetic diagnostics analysis as was made after the recent major coil failure to determine when it had really begun. This action is considered by the Panel as necessary for start-up." Progress on this topic has not been covered in the CDR. Implementation plans should be presented.	Huguet Michel	This review was mainly focussed on mechanical aspects of the Project. There is recovery project scope for shorted turn detection in the Realtime Control and Protection OBS.	Hoffmann	Not in scope of this review
CDR46	8/2/2017 14:59:03	Machine Instrumentation	The draft talk on this topic noted that the lower spoked lid was segmented. This implies that it will have different peak stress regions from those of the monolithic upper spoked lid, and hence it should have different "most meaningful" points where the strain should be monitored.	Tom Todd	will revist the locations ont he spoked lids	Titus	Locations will be determined by access, the objective is not to maesure a specific location, but a place that can be used to estimate the torque
CDR47	8/2/2017 15:14:49	Machine Instrumentation	Consider alternative sensing technology measuring continuously along an optical fibre instead of in discrete positions only (via Rayleigh scattering, see e.g. http://www.sensuron.com/summit/ & http://lunainc.com/wp-content/uploads/2013/04/photonik_intl_2012_010.pdf). Capabilities of this technology are to be checked	Christian Vorpahl	Will look into this. Thanks	Ellis	Good suggestion, but incompatible with current status of desing

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			against (measurement) requirements, cost, etc. As an example, for the Outer TF leg, one or two of such distributed measurement instances (=legs equipped) could enhance the understanding of the structural behavior significantly.				
CDR48	8/2/2017 15:18:36	Machine Instrumentation	Confirm that FISO sensors are compatible with Optsense signal condition, and do so soon enough so that there is time to take action if they are not compatible	Neumeyer	Concue	Ellis	Agreed
CDR49	8/2/2017 15:27:53	Machine Instrumentation	From ITER I knew about the aging effect on fiber optical devices due to radiation. What about NSTX?	Feng Cai	Systems rely on frequency, not amplitude. Similar were used for numerous years on AUG.	Ellis	Document for no
CDR50	8/2/2017 15:30:12	Machine Instrumentation	Fiber optic sensors can be impacted by the phase change of the light which is dependent upon the light path through a magnetic field. Have these sensors and test rights incorporated plans to verify that they are not impacted by magnetic fields?	Matthew Reinke	Will review literature	Ellis	Document that they are OK
CDR51	8/2/2017 15:38:21	Machine Instrumentation	If you want to monitor strains and motions induced by halo current effects, I advise making the datacq sampling rate on the strain gauges etc. of the relevant components (e.g the radial struts) at say 10kHz, not just 1kHz or less, and using a time stamp (fiducial) with an accuracy of no worse than 10 microseconds with respect to the physics side datacq of Mirnov coils, equilibrium sensors etc. A physics VDE detection could be used to centre-stop a continuously running datacq system so that only a burst of data bracketing the event was recorded at the high rate.	Tom Todd	should assess if there is any mechanical content at these high frequencies. We will assess timing in the systems to ensure they can be mapped to events.	Titus	Document not necessary (vessel is an integrator, these are vessel not magnetic measurements)
CDR52	8/2/2017 15:41:32	Machine Instrumentation	Generally the maximum range of strain intended for the strain sensors was said to be 2000 microstrains (i.e. 0.2%, the onset of plastic behaviour in many materials). Where incipient failure is to be monitored, e.g. in the TF centre stack (or "vault"), the strains on the composite assembly could easily be much larger than that, e.g. torsion of the vault when the TF conductors are debonding.	Tom Todd	Need to identify small strains for sure, so that we can detect incipient problems. Will look at ranges again.	Titus	Interested to capture incipient failure, not past it

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CDR53	8/2/2017 16:11:38	Machine Instrumentation	In regard to the TF torsional Twist, if there is a big twist, then its upper lateral retainers should subject the force at not only the radius direction but also circumference direction. The design of the CS stability should consider both directions. I am thinking of a modification of a triangle structure for the existing design of the stabilizer.	Feng Cai	"tiny"	Titus	document - small effect
CDR54	8/3/2017 9:52:28	Machine Instrumentation	For the TF coil outer leg, a strain measurement on the surface is intended to monitor the possible risk of internal de-bonding. But how large is actually the effect of complete internal de-bonding on the bending stiffness? Corresponding to a 10%, 50% or 80% stiffness reduction? Is the measurement capable of detecting critical damage in an early stage? Proposal: Modelling of as-built vs. (not yet critically) degraded coil under operational load and verify resulting surface strain at sensor location is well in a range detectable by envisaged hardware.	Christian Vorpahl		Titus	area of concern is where defect is much smaller
CDR55	8/3/2017 9:58:28	Machine Instrumentation	For sensor mounting on metallic surfaces, consider using electrical spot welding (low cost/high efficiency) as an alternative to epoxy bonding. Benefits are high repeatability and long-term stability.	Christian Vorpahl		Ellis	will consider
CDR56	8/3/2017 10:12:21	Machine Instrumentation	Strain sensors in areas such as on the spoked lid are intended to enable reconstructing loads (here: global torque). Using a limited number of mechanical sensors in discrete positions to reconstruct structural load results in inverse mathematical problems (non-deterministic, especially with regard to sensor noise), which are not stable and/or solvable if ill-defined. The inverse algorithms used to calculate the load (e.g. inverse FE approximation models) usually multiply sensor noise and (if the reconstruction is the main requirement of a given sensing system), define the measurement requirements: Number, location and capabilities of sensors. Proposal: Run inverse calculation for spoked lid asap (and other cases if appropriate) to verify chosen sensor type and locations.	Christian Vorpahl		Titus	interesting but out of scope
CDR57	8/2/2017 9:21:15	Plasma Facing Components	Geoff Fishpool (and doubtless others) was basing HC force and torque analyses in MAST-U on a	Tom Todd	discussed	V Riccardo	Document

	Time stamp	Applicable Area		Submitted by:	Initial Comment	Responsible	Post-review comment
			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.				
CDR58	8/2/2017 9:31:49	Plasma Facing Components	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?	Reinke (for Dennis Mueller)	will assess,	Loesser, Gerhardt & Reinke to consider strategy	Insufficient definition to be considered in the requirements
CDR59	8/2/2017 9:47:18	Plasma Facing Components	IBDV (and others) - the 'dishpans' included in the lower heat flux regions are toroidally symmetric but the heat flux requirements are not. Evaluate if there's an advantage in heat flux handling while not complicating fabrication to make these asymmetric.	Matthew Reinke	Will assess	Loesser	will assess as appropriate
CDR60	8/2/2017 9:56:26	Plasma Facing Components	IBDH - there is a lot of additional metal between the original flange and the plasma: the heating/cooling plate and the carrier plate. At the end the fixings on the original flange (or a variation of these) will have to take a much larger EM load during disruption.	V Riccardo	Will assess	Titus (Integration)	cocur, will be evaluated
CDR61	8/2/2017 10:20:33	Plasma Facing Components	investigate thermal fatigue cycles on graphoil sheets on IBD-H,V, optimum compression required	Dennis Youchison	Will assess	Loesser	will use preload mechanisms to accomodate any "set" of the grafoil; provide a design with an allowance. This will be addressed as part of the PDR.
CDR62	8/2/2017 10:24:54	Plasma Facing Components	Better specify the maximum inter-shot temperature requirements for the purposes of diagnostic integration.	Matthew Reinke	Will assess	Loesser	Define the temperature limit that diagnostics must accomodate.
CDR63	8/2/2017 10:45:21	Plasma Facing Components	Mounting the IBDH/IBDV castellated tile with a single fixture down the center could lead to rotation around that axis to take up tolerances. This leads to a change in heat flux angle which could be large relative to the shaping, leading to tile-to-tile changes	Matthew Reinke	Will assess	Loesser	Concur, will assess as part of PDR

	Time stamp	Applicable Area		Submitted by:	Initial Comment	Responsible	Post-review comment
			in surface heat flux. Complete tolerance study impact on expected heat flux (different than other tiles) and consider alternate fixation if necessary.				
CDR64	8/2/2017 11:04:22	Plasma Facing Components	If the intention is to effectively remove heat through casing cooling, good thermal contact between IBDH tiles with underneath carrier plate is important for heat removal and reduced thermal stress in carrier plate, heat transfer plate and inconel casing. If it is ok for tiles to raise to 600 c (bulk perk), then it is better to thermally insulate the tile and the carrier plate, and have a way to remove the heat radiated to other area in the vacuum vessel.	danny cai	Will assess	Titus (Integration)	Will assess as part of PDR, in consulataion with Loesser & Sibilia
CDR65	8/2/2017 11:33:26	Plasma Facing Components	On the OBD R1/R2 there are many front surface access holes. Consider adjusting design to avoid these totally or so they are between gaps.	Matthew Reinke	concur	Loesser	concur, will be shown at PDR
CDR66	8/2/2017 11:40:42	Plasma Facing Components	I quite like the castellated tile option (because I favour the much smaller component count) but only if it can be shown to have very small tension stress in the graphite at all times through the heating and cool-down cycle. Given some significant stresses at the root of the grooves where the single (?) tie-tube pulled against it, why not introduce more tie-tubes in each tile to spread the load better?	Tom Todd	will assess. Try not to overconstrain...	Loesser	will determine this optimization as part of the PDR design. Opotimal design depends on cost/stress/complexity. Final design WILL have acceptable stresses.
CDR67	8/2/2017 11:46:43	Plasma Facing Components	The combined (IBD-H + IBD-V) is costed significantly higher than the OBD R1/R2 on a per area basis. (Ratio will vary depending on how whether you count low heat flux surfaces, etc., but is around 150% or higher). Since the design proposals are very similar, concerns about manufacturing many parts and alignment driving costs should be equally applicable (or inapplicable) to both regions.	M. Mardenfeld	update costs and schedule for upcoming review	Loesser	Details of the costs were not discussed in detail at the review. WAFs will be updated as the designs evolve.
CDR68	8/2/2017 12:06:54	Plasma Facing Components	OBD R3-R5: While heat fluxes are lower, the OBD tiles will be impacted by faceting (see PFCR-MEMO-005). If tiles are modified, ensure they can meet allowables including enhancement due to faceting. If tiles are remade, consider shaping the front surface to undo local faceting.	Matthew Reinke	will assess	Loesser	concur, will assess as part of the PDR design.
CDR69	8/2/2017 12:07:49	Plasma Facing Components	The outer and inner vessels are supported independently. While outer divertor tiles supported	Ron Parker	will assess	Loesser	tolerance of displacements will

	Time stamp	Applicable Area		Submitted by:	Initial Comment	Responsible	Post-review comment
			by the copper plates can be accurately positioned relative to the inner horizontal divertor during assembly, what magnitude of permanent relative displacement might occur as a result of halo current forces and thermal displacements during operation, and what would be the effect on the performance of the tiles at the interface between inner and outer divertor?				be assessed as part of the PDR. This includes all EM and thermal displacements, none of which a re permenant in the present reuirements and design set.
CDR70	8/2/2017 12:08:24	Plasma Facing Components	OBD R1/R2: Consider shaping plasma facing surface to avoid heat flux enhancement due to faceting of the OBD support structure (see PFCR-MEMO-005).	Matthew Reinke	will assess	Loesser	see above; same response
CDR71	8/2/2017 12:52:19	Plasma Facing Components	In the analysis regarding the PFCs, it was suggested that the PFC would be adequately cooled only by radiation and that a grafoil sheet would only improve thermal transfer from here. THis may be the case but it may also act as a radiation shield. Please could the design team ensure that it is content with this assumption going forwards. Note this is only a concern at low pre-loads where the conduction heat transfer is poor	Rob Bamber	concur	Loesser	concur that lightly loaded grafoil may make situation worse; will assess as part of the PDR.
CDR72	8/2/2017 12:55:02	Plasma Facing Components	Failure criteria of graphite. Please could the design team review their design criteria wrt stress and the cyclic loads on the graphite. I have provided some information to Mike Mardenfeld regarding what was done for MAST tiles and can be available for further comment as required	Rob Bamber	thanks	Titus	Pete will give us some feedback on this; how will it impact the risk profile of the project
CDR73	8/2/2017 12:59:24	Plasma Facing Components	I am slightly concerned by the pin design for the centre column tiles. Particularly the following points; I) the stresses reported are hertzian, i.e. very localised are we confortable that the solution is converged. ii) particularly the floating tile concenrs me, I have not analysed this in any detail but the load appears to be taken over a small area. Push fitting the bushing from both sides may be challenging iii) as mentioned by another participant, I am worried that the thermal expansion difference between the tile and supporting structure and if tis an be accommodated by the 4 pins. Again this may be	Rob Bamber	Concerns are shared. Testing is ongoing to assess these issues, and analysis will be done for PDR	Loesser	Concerns are shared. Testing is ongoing to assess these issues, and analysis will be done for PDR

	Time stamp	Applicable Area		Submitted by:	Initial Comment	Responsible	Post-review comment
			exacerbated in the floating tile due to the geometry here Please could the design team review in the phase prior to PDR				
CDR74	8/2/2017 13:52:20	Plasma Facing Components	OBDR3-5 large pins may interfere with existing design of Mirnov coils. This can be resolved by i) redesigning the Mirnov coils to fit in a new location, or ii) shifting the large pin towards one end of the tile (if allowed). Note also that CS 2D Mirnov sensors are ~0.1" thicker than OBD Mirnov sensors...be careful to design for the right one!	Stefan Gerhardt	concur	Loesser	Concur; additionally concerned about the thermal stresses and local temperatures in cases where the T-Bar is located under the Mirnov.
CDR75	8/2/2017 14:57:11	Plasma Facing Components	Really an integration chit: The OBD R1/R2 design is presently "high heat flux". We have not defined, however, a reasonable means of pulling that heat out. That is to say, the plumbing on the OBD also passes through the plates. Do we intend to run gas cooling through both the IBDH and the big OBD/PP loops?	Stefan Gerhardt	concur	Titus (integration)	concur. Analysis is doing local and global models to assess these issues.
CDR76	8/2/2017 16:12:49	Plasma Facing Components	The BBQ rails are not very symmetric to the vessel nozzles (I recall ~0.1" "errors"). The design should accommodate these as-build conditions.	Stefan Gerhardt	Will assess impact via metrology	Loesser	concur. Metrology is the first step. Will need to assess going forward
CDR77	8/2/2017 16:14:30	Plasma Facing Components	The PFC Halo current force needs to be calculated and verified by the worst case of 96 scenarios in the background magnetic fields of global model.	Jiarong Fang	Must include fields due to displacement of the plasmas	Titus	Will use our best estimates of the field from the displaced/disrupting plasmas.
CDR78	8/3/2017 11:44:14	Plasma Facing Components	Mechanical loads from disruptions on entire small block assembly with Inconel tray is required for comparison to castellated tiles in addition to off-normal heat loading and, in general, bringing analyses to equivalent levels between the two designs.	Dennis Youchison		Loesser	concur; this back-plate EM loading needs to be assessed for all designs
CDR79	8/3/2017 11:54:27	Plasma Facing Components	If we are to rely on testing, we should take consideration that brittle material failures means you need to test a number of them because there's a distribution of results from testing.	Reinke (Rob Bamber @ Breakout)		Loesser	we intend to rely of vendor data with spot-checks via testing; will use the SDC for safety

	Time stamp	Applicable Area		Submitted by:	Initial Comment	Responsible	Post-review comment
							factors. Conversations with vendor from SGL indicated that their material properties are "gauranteed minima".
CDR80	8/3/2017 11:59:15	Plasma Facing Components	Clarify the means by which we'll to judge the relative importance of different failure mechanisms (included in PFC requirements?) Floating cube/individual castellation may lead to similar impact, but full castellated tile and carrier plate have different failure mechanisms and failure risks.	Reinke (for Reinke @ Breakout)		Loesser	Will rely on the design criteria and analysis for a first line of defense...must meet the SDC. Will consider forming an FMEA for the design options.
CDR81	8/1/2017 9:33:22	Polar Region	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	Ron Parker	Short presentation being prepared by JEM	J. Menard	Jon prepared a presentation. Is still open.
CDR82	8/1/2017 14:11:18	Polar Region	For the PDR, if not shown later in the CDR, please analyse the stresses in the female threads where the Inconel 718 20mm (?) bolts engage with the divertor support flange. I think there will be thread inserts there, but I could worry about the parent material if it is not Inconel 625 or stronger, especially as these are short, blind, threaded holes.	Tom Todd	concur	M. Sibilia	Flange is 625. Bolting analysis will be shown a the PDR.
CDR83	8/1/2017 14:12:02	Polar Region	I may be misunderstanding, but it appears that there are blind tapped holes on the air side of the CS-Casing Flange which are intended to interface with highly preloaded inconel studs. Is there sufficient depth to allow a proper number of threads to engage? (Typically blind tapped holes do not have fully formed threads all the way down....)	M. Mardenfeld	concur	M. Sibilia	see previous chit.
CDR84	8/1/2017 14:21:04	Polar Region	Further to my chit about the stresses in the blind tapped holes in the divertor support flange, it was said that an archaic centering step of that mechanical joint could be welded if desired. So why	Tom Todd	welding i) makes it tough to reach organ pipes weld, and	M. Sibilia	Will address this choice as part of the PDR.

	Time stamp	Applicable Area		Submitted by:	Initial Comment	Responsible	Post-review comment
			not make this a structural weld good for the launching load (etc.) and then the bolts become very short and only secure the other end of the box-like sections to the big flange, where the flange on the box-like section can be arbitrarily thick? 22mm SS bolts instead of 20mm Inconel, maybe?		ii) may distort. Will continue to assess.		
CDR85	8/1/2017 14:33:10	Polar Region	Consider limit the highest temperature viton orings will see to 170C to prevent compression set of orings at elevated temperature	Danny Cai	Update the requirement document, getting update from D. Cai and W. Blanchard	S. Gerhardt	concur, will adjust.
CDR86	8/1/2017 14:38:01	Polar Region	In the requirements presentation, a bullet states that the single ceramic insulator must be rated for a minimum of 100V. Will there be an exception for this component for 2E+1kV testing?	Joe Petrella	Update the requirement document for true 2E+1 = 1 kV	S. Gerhardt	concur. Will adjust the requirement for a 2e+1 ~1 kV
CDR87	8/1/2017 14:46:02	Polar Region	The design concept for implementing double o-rings on the CS bellows by welding on an adapter plate leaves a large, abandoned in place, entrapped volume from the obsolete o ring groove. Consider pumping this space along with the interspace between the o-rings.	M. Mardenfeld			Present design calls for there to be a venting mechanism (bold holes). So likely not an issues.
CDR88	8/1/2017 14:53:32	Polar Region	Consider have half dovetail oring groove when orings are at top part of the sealing for easy installation.	danny cai	May consider. Not obvious if it is better	M. Sibilia	Only one place with this condition in the present design, on the ceramic break. Will assess this potential design improvement at PDR, including spatial requirements of this design.
CDR89	8/1/2017 14:59:24	Polar Region	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	Dennis Mueller	out of immediate scope for this review	J. Menard	see above

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			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.				
CDR90	8/1/2017 15:17:04	Polar Region	Is vessel flange capable of supporting lateral load with frictional clamping with only 18 bolts in tension?	Marc Sibilia	Concur	M. Sibilia	concur, will assess pre-loads and frictional interactions, need for pins or lip or bushings or....
CDR91	8/1/2017 15:17:35	Polar Region	The pumping speed that can be achieved between O-rings forming double O-ring seals needs to be evaluated to determine the tolerable leak rate of the double seal.	Ron Parker	Concur	M. Sibilia	Will address at PDR.
CDR92	8/1/2017 15:19:34	Polar Region	Regarding the radius rods: the weakest link in the load path is likely not the uniaxial stress in the solid bar, but connection to the vacuum vessel needing to reacting the bending moment trying to upend the clamp, and the local stress in the plate.	M. Mardenfeld	Will be addressed as PDR process	M. Sibilia	will address at the PDR.
CDR93	8/1/2017 15:29:07	Polar Region	In the requirements document, there should be a temperature limit for the O-rings and I recommend that it be less than 180C, preferably at 150C for Viton.	Arnie Kellman	concur, SPG update spec with guidance from D. Cai and W. Blanchard	S. Gerhardt	see above
CDR94	8/1/2017 15:31:32	Polar Region	Regarding weld on a flange with double o-ring onto the flange welded to casing bellow, consider add four narrow grooves 90 degree apart from air side on the added part to allow helium reachable to the welds	Bill Blanchard	Will assess as part of PDR	M. Sibilia	concur. Also addresses a DVVR chit on incluing leak checking methods

	Time stamp	Applicable Area		Submitted by:	Initial Comment	Responsible	Post-review comment
			from air side in case there is a break on the welds and one tries to do helium leak check				in the design.
CDR95	8/1/2017 15:35:05	Polar Region	The radial link anchor distance will change as the CS changes in length. The rod end bearings shown in the presentation usually have zero free play. Needs to be considered in the design.	L. Dudek	will assess as part of PDR	M. Sibila	Probably no issue, will be shown at the PDR.
CDR96	8/1/2017 15:36:00	Polar Region	Assess if the frictional restraints in the vicinity of the ceramic break are acceptable under the present design, considering the required decrement of the friction coefficient from the design criteria and the observed loss of preload. Use high friction coatings on the flanges that mate to G7 parts?	Stefan Gerhardt	will assess as part of PDR	M. Sibilia	concur, will address at PDR.
CDR97	8/1/2017 15:54:06	Polar Region	Using a continuous welded reinforcement between the CS Vertical Section and the CS Flange seems to introduce a large vertical leak. Even if this space was vented, the continuous structural ring would preclude access to the the vacuum seal weld if there was an issue. Consider accepting welding starts and stops, which should be allowable under the NSTX-U structural criteria for thermally driven peak stresses, in order to design a reinforcing scheme which allows better access.	M. Mardenfeld	will assess as part of PDR	M. Sibilia	Can be vented with holes. Should add provision so that these weds could become the vacuum seal welds. Will assess further as part of PDR process.
CDR98	8/1/2017 16:11:22	Polar Region	IBDH HTP plate welds all on one side will tend to distort the plate, consider a vacuum oven braze. Best solution, as mentioned, would be to 3d print the plate.	L. Dudek	will assess as part of PDR	D. Cai	Will assess best method, including potential post machining.
CDR99	8/1/2017 16:18:23	Polar Region	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?	Stefan Gerhardt	concur	P. Titus	concur, see above.
CDR100	8/1/2017 16:30:09	Polar Region	For the heating plate design consider interfaces with and requirements for the Helium Heating / Cooling system a priority so that we can early on identify scope and cost for modifications to the system (or a new smaller system). Modifications necessary to use the Helium system during daily operations would also incur cost.	Mike Kalish	concur	D. Cai & J. Petrella	concur. Will start with analysis of the thermal system and then drive this into requirements for cooling systems.
CDR101	8/1/2017	Polar Region	Consider using a co-axial or bi-axial feed on the	Jon Menard	Will assess	D. Cai	concur.

	Time stamp	Applicable Area		Submitted by:	Initial Comment	Responsible	Post-review comment
	19:27:20		cooling plates so that two can be fed independently using the presently assigned feedthroughs.				
CDR102	8/2/2017 13:45:47	Polar Region	Cooling plate systems appear to have an OD that is too large given present allowed 1/4" growth for permanent components. Either the space allowance needs to grow, or the plate needs to shrink. This should be resolved for PDR.	Stefan Gerhardt	concur	Sibilia	concur
CDR103	8/2/2017 13:39:51	Test Cell Shielding	I understand that when the protons in plastic neutron shielding absorb a neutron (creating deuterium), there is a 2.23MeV prompt gamma ray emitted as a result. This needs to be shielded against with something other than more plastic, of course, like a good thickness of metal with lots of electrons per m3. Probably Eric etc. already know this - sorry!	Tom Todd	yes	Perry	See Ascione response in email of 8/2/17, 11:02 PM, regarding boron in the intended shielding.