NSTX

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Chit Review

L. Dudek

and the NSTX Upgrade Team

NSTX Center Stack Upgrade Peer Review
LSB B318
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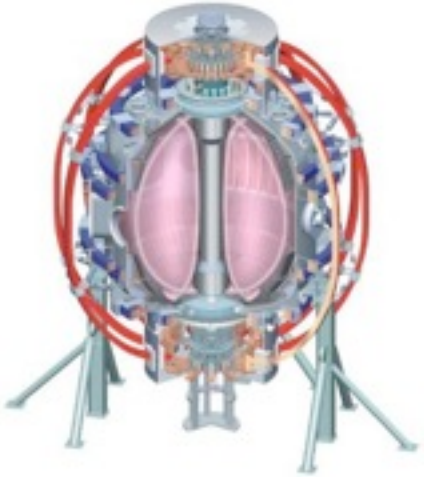

Management

Comment or Concern	Owner	Response / Status
Establish and implement a staffing plan to CD-2 that accounts for monthly assignments of specific tasks, self-consistent with the resource-loaded schedule.	RS	Staffing plans will be prepared that show individuals by name and their loadings by month. These were prepared on a 6-12 month rolling wave for the December 2009 OFES review.
Assure that all Job Managers show ownership of their scope, cost, and schedule by communicating their WAF content and obligations at next Lehman review.	RS	Job manager training and reviews underway.
Evaluate current risk registry and attempt to make more pro-active mitigation strategies.	RS	The RR will be reviewed and mitigation plans expanded.
Consider changing name “Risk Management” to a “Risk & Opportunity” Management, to encourage cost reduction ideas, integrated into WAFs and registry.	RS	Will revise
WBS 1.8-Maintain / advance design development so that down stream critical path activities (like WBS 1.8) can better define scope, activity detail and risks.	RS	Concur. Will factor in design maturation into the field ETC
WBS 1.8-EVMS Validation – start early	RS	Concur. Pre-Validation tasks begun. Procedures being updated, training scheduled for 10/27,EVMS statusing begun. On-going
WBS 1.1.3-Consider having fewer reviews but longer durations	RS	Concur for the review under the project's control.. Future review will allocate sufficient time for more in-depth assessments.

Power System

Comment or Concern	Owner	Response / Status
Raising TF feed current to 130Ka raises concerns about inductive energy stored in busswork, switchgear etc and consequences of failures. Need thorough FMEA including power supplies.	Raki	Inductive energy stored in DC bus, switchgear, etc., is small compared to energy stored in coils, which could potentially be dissipated at any location in the circuit depending on fault location and conditions. Maximum NSTX inductive energy is in the TF system, about 36MJ. This is only about 3% of the stored energy in the TFTR TF coils, for which the system was designed. FMEA has been prepared and identifies the fault conditions.
Consider using capacitive discharge testing on OH solenoid to test inter-turn and inter-layer insulation.	Raki	This test is still under consideration. With the OH wound on the TF bundle the test may be difficult to implement .
Prior to (say one month before) the planned shutdown, as part of the ARR, all Job Managers must declare all materials are on hand, and account for them.	Raki	Agree in principle. Will schedule within schedule priority and available funding. Sub-contract for installation will be awarded only after the receipt of all the materials

Power System

Comment or Concern	Owner	Response / Status
Conduct a design review of the Digital Coil Protection system with external reviewers to include consideration of the coil current combinations, analysis of the loads and overall system design including software and reliability requirements for all components and instrumentation prior to the Final Design Review in 2011	Raki	This is getting addressed in the FDR of the Digital Coil Protection by Ron Hatcher.
Include contingency quantities for components or equipment that are long lead, critical for the first plasma milestone, critical for subsequent operation on, and/or are one-of-a kind.	Raki	The DC CLR for OH will be ordered giving sufficient time for delivery.
Permit Power System installation as soon as possible to minimize interferences, escalation of cost of materials, escalation of cost of labor.	Raki	Agree in principle. Will schedule within schedule priority and available funding allowing ample free float. Project Manager is requested to allow installation activities to begin six months earlier than currently planned.

Analysis

Comment or Concern	Owner	Response / Status
Look at how many cycles have already been performed on components -> get accurate count. Then specify how many new/ extra cycles are needed. Is it 30,000 / 3,000 more or 60k?	Titus	IN PROGRESS: Fatigue qualification is based on analysis, and on in-service inspection. On new components for the upgrade we calculate fatigue life and check to make sure it complies with the NSTX structural criteria document. Analysis is also being done to qualify old components which are being added to a list. Parts will be monitored via a maintenance procedure
Write a design specification to collect and identify all design critical components which exceeded allowables that would guide DCPS design.	Titus	IN PROGRESS: Each detailed stress analysis section will outline the algorithm that will be incorporated into the DCPS. These will be listed by reference to the calculation in a design load specification which simply will be a list of algorithms and their calculation number sources. The calculations will be "living documents". A Protection and Algorithms document will be provided as a deliverable with the DCPS.
TF centre rod temperature close to flags is over 100C and may creep under stress. Consider shaping the wedge/flag area to reduce peak temperatures and stress.	Titus	CLOSED: A Cyanate Ester blend was chosen for the epoxy system. This resin system with shear and tensile stress allowables high enough that local high spots in the TF corner are no longer a problem. (Ref: CTD Cyanate Ester Tests)
Divertor surfaces could get quite hot. Need thermal analysis of temp. in o-ring region to ensure o-rings wont melt, or spec. cooling requirement	Brooks	CLOSED: Thermal analysis has been completed and it was determined that additional cooling will be required in that area to protect the o-rings. Plans to provide additional cooling have been added to the NSTXU design.

Centerstack Coils

Comment or Concern	Responsibl	Response / Status
Better determine the strength of the CD107 copper alloy at 100C by either direct measurement or published data specific for this alloy,	JHC	CLOSED: Published data indicates about 10% reduction at 100C which is acceptable to this design.
Produce a TF/OH manufacturing plan, including a fabrication facility design, for the PDR. Identify hardware that needs to be purchased “a schedule” This is a task we want to get started on before the FR/CD3 thus we need to ask for DOE permission.	JHC	CLOSED: A TF/OH manufacturing plan has been completed document no. NSTX-PLAN-MFG-1300.
What R&D wont be complete by the PDR and clearly show what assumptions are being made for estimating purposed. What impacts if R&R is not successful (show in risk registry)	JHC	Following testing has been completed: 1. Aquapour pour and removal tests for winding OH coil, 2. CTD shear bond tests, 3. Flex Connector Cyclic Testing, 4. Insert pullout tests, and 5. FSW Tests Only testing left to complete is Supernut tension tests to be done by FDR
Check strength and modulus of room temperature stycast (epoxy)for use on the TF castle (teeth).	JHC	Concur. The TF teeth/crown structure will be fabricated in-house with a wet layup process with glass positioned circumferentially in structure to provide maximum strength. Design was modified to reduce stresses on the epoxy composite. The glass layers are oriented for maximum strength. Stycast will not be used.

Center Stack Coils

Comment or Concern	Owner	Response / Status
Primer for copper: If CTD can develop a new high temperature primer it may need static and fatigue testing. If not then could use cyanate ester based primer but be aware of safety and handling issues.	JHC	CLOSED: New primer CTD-450 is being used with resin CTD-425 hybrid. The shear bond tests were conducted and qualified using this resin and primer system.
Centre stack and solenoid insulation - Demonstrate the shear bond strength between the insulation and the copper by testing.	JHC	CTD-101 to be used on OH / Inner PFs and is qualified for shear stress. Attempting to qualify fatigue life by literature search. If not will perform a test
Use of Superbolts on electrical connections is a new application. Concern is related to thermal cycling of joint and braze/solder creep under high load.	JHC	IN PROGRESS : Action Plan - Test by cycling a simulated joint equipped with Inconel Studs and SuperNuts - and verify that there is no loss in pretension. The Supernuts are to be tested by FDR.
Slip plane - Add a radial position restraint between the CS and TF to prevent excessive lateral motion during operation	JHC	CLOSED: Using silicone rubber to allow thermal growth.
Solenoid conductor braze joints - Finalize the manufacturing process for the OH conductor.	JHC	IN PROGRESS - Once conductor length can be verified, braze joint process will be finalized. Will be completed during conductor procurement
Structural Design – Define R&D goals, document, and carryout a supporting R&D program for all components and processes to support the design and its requirements and to reduce program risk	JHC	CLOSED: R&D Plan competed with the exception of TF Supernut tests listed above
Refrain from placing contracts for the conductor until after the stir welding processes evaluation has been satisfactorily completed and found to meet mechanical and electrical requirements for the design.	JHC	CLOSED: FSW Tests were completed before ordering copper

First Wall

Comment or Concern	Responsible	Response / Status
Make sure surface area of contact between tiles and backing surface is sufficient for disruption current and heat loads	Tresemer	CLOSED: Disruption current analyses was completed. all forces are inward. Grafoil is being reintroduced. Analysis confirms heat transfer is adequate and stresses are within limits.
Consider using graphite tiles for centre tube even if it needs increasing the centre column radius by a few mm to save cost (and time)	Tresemer	CLOSED: Will be using ATJ graphite on the CS column at GRD specified thicknesses.
At each review, a new tile connection scheme is shown. This latest one has not been used in other fusion machines. May present some R&D. Perhaps going with another fusion experiment's method should be considered.	Tresemer	CLOSED: The design is being changed to welded studs and threaded caps (proven existing NSTX design). Only exception is the use of Spiralock threads to prevent galling and allow reuse.
The definition of the CFC linked to requirements. Density, weave, graphitization temperature all need to be fed back to the design.	Tresemer	CLOSED: All tiles are now ATJ graphite. CFCs are not required.
MAGNETS & CORE(Brad Nelson): Refrain from placing contracts for the PFC tiles until after the prototyping of the tiles and mechanical testing of the fastening scheme is completed.	Tresemer	CLOSED: CFC's were eliminated. ATJ graphite properties are well known. Loading is much lower and stresses are no longer a concern. Most stresses in the divertor tiles are thermally (internally) induced.

Miscellaneous

Comment or Concern	Responsible	Response / Status
TF Outer legs should be characterized for present mechanical strength since they will be subject to higher point loads at support points. Consider using the TF leg removed because of the water leak to get samples for static and fatigue testing.	Dudek	CLOSED: This is no longer an option since the Outer TF Leg removed will be refurbished as a spare.
Ancillary - 14. Obtain operational experience for control systems from other facilities in order to determine the expected reliability and the level of redundancy required to achieve a desired overall reliability.	Hatcher	CLOSED: Taylor from GA and Burke from MIT provided their experiences with these types of systems which is being used as input to the DCPS design.
All NSTX components, including passive plates, etc. must be compatible with the design point. Any modifications which may be necessary must be included in the cost. See GRD 2.1.2.a	Dudek	All NSTX components required for upgraded operations, as described in GRD section 2.1.2, will be compatible with the design point. There are two risks being carried in the risk register to cover passive plate hardware and tiles in the event detailed analysis shows they need upgrade. The weighted cost included in the contingency is $762k.

Miscellaneous

Comment or Concern	Responsible	Response / Status
The insulated joint in the outer TF support should be reconsidered if it is necessary and if necessary how is shear load carried.	Smith	CLOSED: Verified by Physics that electrical breaks are not required.
Convene external peer reviews / verification of key aspects of the design and analysis, especially the TF joint electrical design and the algorithms to be used for the digital coil protection system, prior to the Final Design Review (FDR)	Dudek	PENDING: External reviewers are included in the May 2011 peer review and the DCPS PDR to be held in June 2011.
Develop a plan for operating instrumentation to monitor selected displacements, temperatures and joint resistance, prior to the FDR.	Dudek	PENDING: Atnafu is placing displacement instrumentation on existing OTF leg supports to baseline displacements. Also looking into the existing instrumentation on the machine to determine what is required on the new centerstack to monitor displacements and temperatures. Due to the high margin on the new flex joint there are no plans to monitor the resistance.