NSTX-U Recovery Project

C. Neumeyer FES Quarterly Review Presentation includes Preliminary Information August 21, 2017





Outline

- Progress
 - Polar Region Option Downselection
 - Draft Corrective Action Plan (CAP)
 - Conceptual Design Review
 - Work Approval Form (WAF) Preparations
 - Organizational Adjustments
- Future Plans
 - Procurement of Inner PF Coil Prototypes
 - Development of Project Plan
 - Cost & Schedule Review
 - Extent of Cause linkage to NSTX-U
- Financial Performance
- Summary

FY17 Progress + Remaining Activities

			1-Oct-16	1-Nov-16	1-Dec-16	1-Jan-17	1-Feb-17	1-Mar-17	1-Apr-17	1-May-17	1-Jun-17	1-Jul-17	1-Aug-17	1-Sep-17	1-0ct-17
Start Recovery	10/1/16	10/1/16													
Establish Organization	10/1/16	11/1/16													
EoC Plan	11/1/16	11/1/16													
DVVR - CI&C	1/18/17	1/18/17													
DVVR - Project Integration	1/24/17	1/24/17													
DVVR - Heating Systems	1/30/17	1/30/17													
DVVR - Magnets	2/7/17	2/7/17													
DVVR - VV & Int Hdwe	2/14/17	2/14/17													
DVVR - Cooling Systems	2/22/17	2/22/17													
DVVR - Power Systems	2/27/17	2/27/17													
EoC Committee Review #1	3/6/17	3/6/17													
DVVR - Test Cell	3/16/17	3/16/17													
DVVR - Vacuum & Fueling	3/23/17	3/23/17													
DVVR - Bakeout	3/30/17	3/30/17													
Interim EoC Notable Report	3/31/17	3/31/17													
DVVR - Diagnostics	4/5/17	4/5/17													
DVVR - RT C & P	4/19/17	4/19/17													
Design Integration Review	4/21/17	4/21/17													
WAF Preparation	5/15/17	8/30/17													
EoC Committee Review #2	5/15/17	5/15/17													
Polar Region Option Downselection	6/4/17	6/30/17													
Inner PF Coil Prototype Procurement	6/19/17	9/11/17													
Draft EoC Notable Report	7/18/17	7/18/17													
Conceptual Design Review	8/1/17	8/3/17													
	TODAY														
Cost & Schedule Review	9/6/17	9/8/18													

Polar Region Option Downselection

National Spherical Torus eXperiment Upgrade

Evaluation of Options Related to Polar Region and Center Stack Bakeout

NSTX-U-DOC-001-01



- Risk/Cost/Schedule assessment of design options for Polar Region
- Recommendation:
 - Single ceramic insulator, upper only
 - Double O-rings with pumped interspace on all seals
 - Retain DC current injection for center stack bakeout heating
- Reviewed and accepted by Tom Todd, Chair of EoC committee

Draft Corrective Action Plan (CAP)

PPPL Objective 2.1 Draft Notable Outcome Report



Office of Fusion Energy Science Office of Science U.S. Department of Energy

July 18, 2017



- Summary of outcome of Design Validation & Verification Reviews (DVVRs) and Extent of Condition (EoC) committee recommendations
- Presents preliminary cost & schedule estimate
- Accepted as a draft, pending the vetting of cost and schedule information via a Cost & Schedule Review (C&SR)

CAP Scope Categories

Recovery Scope	Maintenance and Run Preparation	Operations Enhancements for Improved Reliability
Scope to address DVVR issues or EoC recommendations related to design, fabrication, or installation that remedies severe design deficiencies or performance limitatations	Scope to address reliability of critical components in supporting infrastructure outside tokamak core; need not be a DVVR issue but could have been identified in the DVVR or EOC recommendations	Deferrable scope that addresses reliability of less critical components; need not be a DVVR issue
Scope to address DVVR issues related to reliability of the tokamak core (PFCs, magnets, vessel, etc.)	Routine maintenance and repair tasks; need not be a DVVR issue but could have been identified in the DVVR or EOC recommendations	Desirable but not esssential enhancements
Scope to address any known safety issue; need not be a DVVR issue	Critial scope that was planned before the start of the Recovery Project	
	Operations support functions (minimal staff opertions, allocations, energy consumption, etc.)	

CDR Addressed Six Major Scope Areas Identified in CAP

Mational Spherical Torus eXperiment Upgrade

INT-170724-CLN-01

TO: DISTRIBUTION FROM: C. NEUMEYER SUBJECT: CHARGE FOR CONCEPTUAL DESIGN REVIEW – REV. 2

1 Introduction

The NSTX-U Recovery Project recently completed the Extent of Condition (EoC) review and the final report of the EoC committee has been received. The EoC process identified a set of issues that serve as input to a Corrective Action Plan (CAP). Various corrective actions have been identified for all the NSTX-U subsystems, but a subset with the highest priority and impact are concentrated in a few key areas. A recent Design Integration Review (DIR) covered a subset of these key areas in the polar regions and generated a set of chits that need to be addressed and closed. Exploratory studies of options for re-design of NSTX-U in these key areas are nearing completion. A Conceptual Design Review (CDR) of these studies and the options considered is a necessary step toward moving forward with the NSTX-U Recovery Project.

This CDR will take place before completion of the PPPL Extent of Cause review and before actions items from that review are closed. To ensure that the CDR is rigorous and compatible with the greater level of design assurance that will be required once the Extent of Cause actions are in place, ENG-033 requirements are imposed as a baseline, with supplemental requirements as follows:

- Review charge, objectives, and input documents are clearly delineated via this memo
- Engineering Department Head, as acting Technical Authority of PPPL, will chair the review, acting with independence from the NSTX-U Recovery Project
- Committee shall include subject matter experts in each topical area, with a minimum of one such expert per topical area from an institution external to PPPL
- Committee shall include the NSTX-U Responsible Engineers and representatives from the PPPL Quality Assurance and Environmental Safety & Health groups

In addition it is noted that:

 Requirements that have evolved since the baseline NSTX-U requirements documents (including Design Point Spreadsheet) are highlighted as tentative for

- Inner PF Coils
 - Redesign + replace PF1A/B/C with mandrelless coils
- Plasma Facing Components (PFCs)
 - Redesign + replace to recover heat flux and halo current capacity
- Polar Region Components
 - Redesign and replace
 - Seals + O-rings
 - Coil supports
 - Heating/cooling lines
- Bakeout Systems
 - Redesign and modify to address safety and performance issues
- Test Cell Shielding
 - Improve shielding of penetrations
- Machine Instrumentation
 - Provide system to benchmark analysis and provide trending

CDR Procedure

Title: NSTX-U Repair - CDR				(ENG-032)
Type of Review: 🗌 Peer	CDR.	🗌 PDR	🗌 FDR	
Cog Individual: Charlie Neume	yer		Date of R	eniew: 8/1-2-3/17
Review Board Members:	In	vited attend	ees :	Contributors and Observes
Chairperson V Riccardo	_GAscione			R. Burke
R. Bamber	_B Blanchar	d		D Cai
B Beck	_J Dellas			C Ciummo
M. Cox	_B Ellis			A Jariwala
L Dudek	_S Gerhardt			A Khodak
R. Haange	_R.Hawrylui	k		B Linn
M Hingust	F Hoffman			W Que
A Kellman	_M Kalish_			M Smith
D Kellman	D Losser			Y Zhai
Levine	_M Mardeni	ield		T Brog
F Malinowski	J Menard			L Hill
R. Parker	C Neumey	ar .		D Knutson
T Todd	E Parry			S Langish
R. Vieira	J Petrella			M Zarnstorff
C Vorpahl	S Raftopou	les		D McComas
D Youchison	H Schneide	ar		CReno
	M Sibilia			S Weidner
	T Stevenso	n.		J King
	G Tchiling	uirian		A Indelicato
	P Titus			P Johnson
	4 mm H-ll			MI metet
	M Reinke	•		S Rogan
Items Reviewed:		Sat.	Unsat.	Comments or n's if not applicable
Appropriate requirements identific	ed	X		
Development plans and schedules				N/A - cost and schedule review 9/6-8/17
Regulatory compliance including	USI/USID an	d		
NEPA				
Disposition of CHITS from previo	sus reviews	×		
Court alize alize a				N/A - cost and schedule review 9/6-8/17
Cost objectives		-	Ξ	

- Conducted per PPPL ENG-033 with added rigor
 - Review charge, objectives, and input documents clearly delineated in advance
 - Chaired by PPPL Engineering Department Head, acting with independence from the NSTX-U project
 - Committee included subject matter experts in each topical area, with a minimum of one such expert per topic from an institution external to PPPL
 - Committee included all NSTX-U Responsible Engineers and representatives from the PPPL Quality Assurance and Environmental Safety & Health groups
- 16 committee members, 13 external

CDR – External Reviewers

Name	Institution
R. Bamber	CCFE
B. Beck	MIT
M. Cox	CCFE
R. Haange	ITER, ret.
M. Huget	ITER, ret.
A. Kellman	GA
D. Kellman	GA
B. La Bombard	MIT
R. Parker	MIT
T. Todd	CCFE, ret.
R. Viera	MIT
C. Vorpahl	ITER
D. Youchison	ORNL

CDR Results (1)

- Achieved purpose stated in charge letter
 - The purpose of the CDR is to review the exploratory studies for redesign of key areas of NSTX-U, to identify the applicable requirements, to define interfaces, to respond to the DIR chits, and to confirm the selection of options to further pursue.
- Positive comments from EoC chair Tom Todd
 - I am happy with the way that this CDR was prepared and managed
 - There was a very clear correspondence of the new design approaches with the recommendations of the EoCR report.
 - The CDR proceeded in a professional way and essentially all queries and discussion points were considered with due attention
- 41 presentations, 103 chits
- Chits have been dispositioned by the committee
- CDR Summary Report was issued on August 13

CDR Results (2)



Castellated concept



- Inboard Divertor Horizontal (IBDH) and Vertical (IBDV) are the most challenging PFC surfaces
 - High heat flux and strong halo loads
- Two concepts have been identified and path to downselection is nearly complete
 - Bring alternative concept to the same level of analysis maturity
 - Compare technical features (alignment, diagnostics, scenario compatibility,...)
 - If the above steps lead to a similar level of confidence, use cost and schedule to down-select
 - Carry out high heat flux tests on selected concept, reserve alternate as fall-back for risk mitigation



Sample castellated tile EDM cut from Sigrafine material

CDR – PFC Follow-Up

	Co Warve						
5	For						
PLASMA-FACIN	PLASMA-FACING MATERIALS AND COMPONENTS						
169							
HIGH-HEAT FLUX TESTING FOR THE N	OF CANDIDATE MATERIALS AND COMPONENTS						
NSTX	-U-SOW-VV+IH-001-00						
	TED Augure 0 2017						
DA	TED AUGUST 9, 2017						
PREPARED BY: M.	JAWORSKI Literation (1999) (1990-01)						
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	QUALITY ASSURANCE						
REVIEWED BY:	G. D. LOESSER						
	RESPONSIBLE ENGINEER						
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APPROVED BY:							
·····	RLM						
PRIN							
PLASMA	PHYSICS LABORATORY						
501	P.O. BOX 451						
PRI	609-243-2000						

- Downselection meeting will be held August 22
- Four external participants have been invited
 - T. Todd
 - B. La Bombard
 - A. Kellman
 - D. Youchison
- Outcome will be vetted by PPPL management
- Statement of Work in process for high heat flux testing at Penn State Applied Research Lab

Organizational Adjustments



Work Approval Form (WAF) Progress – key input to Cost & Schedule Review

	Work Ap	proval Form (WAF)						
0 4 0 4								
Cost Center:	1150	1150						
Job Number:	4015							
Work Package:	MAGS							
Job Title:	PF1A Coil Re	PF1A Coil Replacment						
CAM:	Steve Raftopoulos							
Description:	Design, fabricate and test replacement Inner PF 1A Coils							
Schedule:	See Tab B or att	achad						
	Steve	Explain specify the Palacole Di unifer Magala, official						
Approvals:	Raftopoulos	Param Reprint Laboratory Interformation Reprint Control (Control (Contro)						
	Job Manager							
	Charles L.	Digitally agreed by Charles I. Normager Diff. conclusion I. Normager, and The						
	Neumeyer 🥖	- Sal ser stalls Hit Set						
	Project Engineer	ing Director						
	Richard J.	Digitally signed by Richard J. Hawryluk						
	Hawryluk 🥖	Date: 2017.08.08 14:52:52 -04'00'						
	Project Dimeter							

- Total 78 WAFs
 - 35 Recovery Scope
 - 29 Maintenance + Run Preparation
 - 14 Operations Enhancements for Improved Reliability
- Status
 - 77 of 78 have undergone initial internal project review
 - 63 are in formal review per PPPL procedure ENG-053
 - 16 have been approved
- Upload to Primavera P6 is in process

Inner PF Coil Procurement (1)

- Four (4) proposals received at end of RFP period 7/21
- Initial screening by PPPL Procurement Department 7/24
- SPEB meeting #1 7/25
- SPEB meeting #2 7/27
 - 1st round questions issued
- SPEB meeting #3 8/7
 - 2nd round questions issued
- SPEB meeting #4 8/11
 - Discuss 2nd round answers
 - Discuss customer feedback (2 references per proposal)
 - Finalize technical review
 - Received cost information
 - Converged on recommendation
- Issued draft SPEB recommendation memo 8/18

Inner PF Coil Procurement (2)

- Next steps
 - Issue SPEB recommendation memo
 - Convene meeting of NSTX-U management to decide on award(s)
 - Award contract(s)
- Impact of FY18 notable outcome
 - Plan for prototypes did not include power testing
 - Features will have to be added to facilitate power testing
 - Bracing of leads, silver plating of terminal pads, other TBD
 - Drawings and specification will be revised
 - Offerors will be given the opportunity to revise their offers
 - Design review will be performed covering changes from prior vetted prototype design including analysis to justify power testing, but we will proceed at risk with procurement
 - Impact on procurement ~ 2 3 weeks delay
 - Impact on contract award for production ~ 2 weeks on each manufacturer, assuming test facility available

Inner PF Coil Procurement (3)

- Proposals include schedules
 - for prototype fabrication, will be written into contracts
 - for production coil fabrication, for information only, no firm commitment
- Schedule information for both prototype and production coils varies significantly amongst industrial suppliers
- PPPL in-house fabrication schedule is in range of the others
- Will clearly need three parallel production lines to meet the present schedule
- The decision on contract awards is critical
 - Will set the critial path of the outage schedule
 - Will provide risk mitigation in case one or more suppliers fail
- May have to wait for another iteration with suppliers, TBD

Development of Project Plan (1)

- Approach
 - PPPL will implement a "Major Item of Equipment (MIE) Like" project approach to achieve the NSTX-U Recovery objectives, but does not envision a 413.3.b project
 - Establish a performance baseline to reinforce project discipline using DOE-SC approved tools and systems
 - Use the Accelerator Safety Order to achieve readiness for restart
 - Use a graded approach to meet the Office of Science expectations for project performance as an MIE project
 - Remain responsive to the findings and conclusions of Extent of Cause and Condition Reviews
 - Meet revised threshold Key Performance Parameters (KPP's) that reflect the needs of the Science program

Development of Project Plan (2)

Path forward

- Draft project documents, to be in place by end of FY'17
- Draft Preliminary Project Execution Plan
- Update / replace draft QA plan and incorporate definition of Graded Approach
- Complete the WAFs and load the Primavera P6 project plan
- Complete project resource / staffing load calculation and initial load leveling
- Begin development of a project risk register
- Complete the initial "project focused" Cost & Schedule Review
- Be ready for an initial baseline review when requested by DOE

Cost & Schedule Review Preparations

- Established committee membership
 - Combination of Project Management experts and senior engineers with project/cost/schedule experience
- Bob lotti will serve as Chair
- Established agenda
- Convened preparatory meeting with REs on 8/8
- Issued templates for presentations and risk input
- Received first risk inputs from REs on 8/16

Cost & Schedule Review Committee

Name	Affiliation	Project Management	PFCs	Magnets	VV + Int Hdwe	Test Cell	Diagnostics	Power Systems	Heating Systems	Bakeout + Cooling	Real Time C + P	Vacuum + Fueling	Central I + C	Integration + Analysis
Bob lotti	Consultant	X												
Arnie Kellman	GA		Х		Х					Х				
Martin Cox	MAST			x										х
Mark Wilson	PU	X				х								
Sam Rozycki	PU	X				Х								
Dale Knutson	Consultant	X												
Thomas Todd	CCFE, ret.													х
Dennis Youchison	ORNL		Х											
Brad Nelson	US ITER - ORNL				Х									
Wayne Reiersen	US ITER			X										Х
Ken Young	PPPL, ret.						х							
Jim Irby	MIT			x		Х		Х		Х				
Dave Rasmussen	US ITER - ORNL								Х			Х		
Steve Hartman	ORNL										Х		Х	
Mike Bebon	BNL	X												

Cost & Schedule Review Agenda (1)

Wednesday, September 6							
Time	Duration	Session	Торіс	Presenter			
			Committee pre-meeting				
8:30	0:20	Committee	discussion	Chair			
8:50	0:05	Welcome	Welcome	Brog			
			Recovery Project Overview +				
8:55	0:40	Project Overview	Cost/Schedule Estimate	Hawryluk			
			Project Management				
9:35	0:40		Methodology	Langish			
			Approach to Accelerator Safety				
10:15	0:20		Order	Von Halle			
10:35	0:15	Break		-			
		OBS					
		Scope/Cost/Schedule					
10:50	0:20	Overviews	Plasma Facing Components	Loesser			
11:10	0:20		Magnets	Raftopoulos			
11:30	0:20		VV & Internal Hardware	Sibilia			
11:50	0:20		Test Cell	Atnafu			
12:10	1:00	Lunch		-			
13:10	0:20		Diagnostics	Ellis			
13:30	0:20		Power Systems	Dellas			
13:50	0:20		Heating Systems	Stevenson			
14:10	0:20		Bakeout & Cooling	Petrella			
			Real Time Control &				
14:30	0:20		Protection	Hoffmann			
14:50	0:20		Vacuum & Fueling	Blanchard			
15:10	0:15	Break		-			
15:25	0:20		Central I & C	Tchilinguirian			
15:45	0:20		Integration & Analysis	Gerhardt			
16:05	0:20		Operations	Von Halle			
16:25	0:20		Project Management	Langish			
16:45	0:15	Committee	Committee discussion	Chair			
17:00	-		End of Day 1	-			

Cost & Schedule Review Agenda (2)

	Thursday, September 7							
Time	Duration	Session	Parallel A	Parallel B	Parallel C			
8:30	1:30	Breakout 1	Overall Project Mgt + P6	PFCs	Magnets			
10:00	0:15	Break						
					RTC & P + Central I & C			
10:15	1:30	Breakout 2	Ops	VV & Int Hdwe	+ Diagnostics			
11:45	1:00	Lunch						
			Accelerator Safety					
12:45	1:30	Breakout 3	Order	Cooling & Bakeout	Power Systems			
14:15	0:15	Break			-			
				Test Cell + Vacuum &				
14:30	1:30	Breakout 4	Integration + Analysis	Fueling	Heating Systems			
16:00	0:15	Break			-			
16:15	0:45	Committee	Committee discussion	Chair				
17:00	-		End of Day 2	-				

Friday, September 8								
8:30	1:00	Committee	Committee Deliberation	Chair				
9:30	2:00		De-brief Writing	Chair				
11:30	0:30		De-brief	Chair				
12:00	-		End of Day 3	-				

Extent of Cause Notable – Linkage to NSTX-U

• EXTENT OF CAUSE

- SC/PSO: Conduct a review of policies and procedures for design, construction, installation, commissioning and operations of NSTX-U and other construction activities and projects. Develop corrective actions to ensure the highest quality project management across the lab.
- NSTX-U Strategic Approach
 - Take pro-active steps to enhance rigor of processes, anticipating findings of Root Cause Analysis/Extent of Cause reviews, in advance of need
 - Examples
 - Established organization structure with Responsible Engineers
 - Developed dedicated NSTX-U QA Plan
 - Conducted DVVRs and CDR with extra rigor
 - Developed Fabrication Oversight Plan to cover in-house fabrication and procurements
 - Participate in PPPL institutional policy and procedure modifications
 - Include Extent of Cause impact on schedule as a risk

Extent of Cause Notable – Fabrication Oversight Plan

National Spher	ical Torus eXperim	ent Upgrade
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Fabrication Oversight Plan

NSTX-U-PLAN-001-00

AUGUST 17, 2017

Charles L. Neumeyer	Digitally signed by Charles L. Neumeyer DN: cm=Charles L. Neumeyer, o=PPPL, ou, email-neumeyer@ppi.gov, o=US Date: 2017.05.15 10:55.45 -04'00'						
Cha	rles Neumeyer						
NSTX-U Recovery Project							
Engi	neering Director						
Frank Malinowski Beason: I have reviewed this Date: 2010.08.16 10:52:59-041							
Frank Malinowski							
NSTX-U	J Recovery Project						
Quality Assurance Representative							

NO- NO

Richard Hawryluk NSTX-U Recovery Project Director

- Dedicated Oversight Plan written for each fabrication above criticality thresholds
- Covers both PPPL in-house fabrications (e.g. coil winding) and subcontracts to industry
- Describes roles and levels of authority of participants
- Requires that Assignment Sheet be issued for each surveillance visit related to specific steps in the plan

Extent of Cause Notable – Linkage to NSTX-U

• PPPL Institutional Plan aims to act on Extent of Cause findings in advance of main wave of NSTX-U activities

		AUG SEPT		PT	OCT		NOV		DEC		JAN		FEB		MAR		APR		MAY		JUNE		
		20	17	2017		2017		2017		2017		2018		2018		2018		2018		2018		2018	
																						I	
STX-U Recovery	Preliminary Engineering																						
	Detailed Engineering																						
	Final Design Reviews																						
Ž	Internal / External Fabrication																						
Institutional CAP	Graded Approach Procedure (CA-1)																						
	New Roles' R2A2s (CA-2)																						
	Design Procedures (CA-5A)																						
	Procurement Procedures (CA-5B)																						
	Fabrication Procedures (CA-5C)																						
	Increased Oversight / Monitoring																						

Summary

- NSTX-U is on track to complete the FY17 notable and other planned activities targeting the Extent of Condition and is planning to execute the Corrective Action Plan starting in FY18 with strong project discipline
- PPPL's ability to deliver and test hardware will be demonstrated via the FY18 notables
- Project is in transition from developing a corrective action plan, to establishing a baseline, to designing/ testing/installing hardware