



**U.S. DEPARTMENT OF
ENERGY**

**OFFICE OF
SCIENCE**

**Closeout Report on the
Review Committee for the
National Spherical Torus
Experiment (NSTX) Upgrade Project**

Princeton Plasma Physics Laboratory

December 12, 2012

Stephen W. Meador

Review Committee Chair

Office of Science, U.S. Department of Energy

<http://www.science.doe.gov/opa/>



Review Committee Participants

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Stephen Meador, SC, Chairperson

Review Committee

Subcommittee 1: Technical

*Arnie Kellman, General Atomics

Will Oren, TJNAF

Bruce Strauss, DOE/SC

Subcommittee 2: Cost and Schedule

*Kin Chao, DOE/SC

Tim Maier, DOE/BHSO

Rick Blaisdall, DOE/APM

Subcommittee 3: Management

*Frank Crescenzo, DOE/BHSO

Chris Ackerman, DOE/SC

*Lead

Observers

Ed Synakowski, DOE/SC

Barry Sullivan, DOE/SC

Tony Indelicato, DOE/PSO

Maria Dikeakos, DOE/PSO

Charge Questions

1. **Construction Efforts:** Are construction efforts being executed safely? Does the project have adequate resources and the appropriate skills mix to execute the project per the plan?
2. **Baseline Cost and Schedule:** Are the current project cost and schedule projections consistent with the approved baseline cost and schedule? Is the contingency remaining adequate for the risks that remain?
3. **Management:** Evaluate the management structure as to its adequacy to deliver the scope within budget and schedule. Are risks being actively managed?
4. **Response to Prior Reviews:** Has the Integrated Project team implemented all required actions in the Corrective Action Plan that was developed following the Project Status review from April 2012?



2. Technical Status

Kellman, GA*/Oren, TJNAF/Strauss, DOE/SC

1. Construction Efforts: Are construction efforts being executed safely? **Yes.** Does the project have adequate resources and the appropriate skills mix to execute the project per the plan? ***The project presently has adequate resources and necessary skills mix to execute the project. However, the impact of the possible loss of key personnel if a laboratory staff reduction is required is unknown.***
4. Response to Prior Reviews: Has the Integrated Project team implemented all required actions in the Corrective Action Plan that was developed following the Project Status review from May 2012? ***The Project team has implemented the required action to update the Risk Registry resulting from the status review in May 2012. Particular emphasis has been placed on using the detailed schedule to manage and accelerate procurements.***



Findings

- **There have been no recordable injuries to date on the NSTX-U project.**
- **The project has realized a schedule slip of 4 months in the last 6 months attributed to issues in the central stack fabrication process. Specifically, additional process development was necessary for fixing flaws in the stir welding, process refinement continued for soldering the cooling tube into the TF conductor channel and the TF quadrant mold top had flaws that forced remanufacturing.**
- **The centerstack fabrication remains on critical path, but significant progress has been made on both CS procurement and fabrication. 38 TF conductors have been delivered, cooling tubes have been soldered into 28, and 13 are primed and wrapped. 36 conductors are required for a full TF bundle. Sufficient material has been ordered for 6 quadrants but only 4 will be fabricated, unless one does not pass tests.**



Findings (cont'd)

- **The VPI process trial was successful and the first quadrant VPI is scheduled for January 2013.**
- **A successful test application and removal of the Aquapour process on a TF-scale mockup was performed.**
- **Ultrasonic inspection of the outer TF coils identified two coils that need repair due to damage in the braze joint.**
- **The NBI Upgrade is progressing well. The task is under cost and ahead of schedule. The second Neutral Beamline was successfully moved into the NSTX test cell in September after completion of the decontamination process. After significant rework of poor welds on the large NB injection port weldment, it is ready for installation.**
- **No technical problems were identified in any of the ancillary systems.**



Findings (cont'd)

- **The Digital Coil Protection System has fallen behind schedule. PDRs for both the hardware and software are planned for first quarter FY13 with task completion forecast by July 2014.**
- **The project has recognized through bad experience with the Neutral Beam Injection port weldment and the TF quadrant mold lid that early inspection of incoming parts is critical for schedule performance. The laboratory has assigned a full time QA person to ensure that QA activities for vendor fabricated parts occur in a timely fashion.**

Comments

- **Construction efforts continue to be executed safely. The work processes developed and implemented by the Work Control Center are mature and combined with the strong ES&H participation assure safe, efficient, and correct task performance.**
- **The project has the key people needed for the centerstack fab and assembly. Both engineering and technician backup personnel have been identified for critical tasks. Judicious use of overtime and second shift has been used to date and should continue.**
- **Because the impact of an electrical fault is so significant, additional electrical tests should be considered. Consider testing the standoff between adjacent TF quadrants w/o VPI to test the electrical integrity of small sections that might remain dry after VPI. A test to failure could be performed on test conductors appropriately wrapped and clamped.**

Comments (cont'd)

- **A more comprehensive electrical test plan for the TF bundle to OH coil and for the OH coil alone needs to be developed and reviewed by the electrical group. The plan should include an impulse test and plans for obtaining and/or building the required test setup must be prepared soon to assure readiness of test equipment when needed.**
- **All aspects of the production process should be tested and optimized prior to beginning the winding of the OH on the TF bundle. A small scale mockup of the OH winding, including winding on Aquapour, should be considered. The process for winding the OH coil is new, the winding machine is new, and insulation requirements are much higher than the TF (9 kV vs. 1 kV).**



Comments (cont'd)

- **While we see no obvious technical problems with the proposed CS assembly, the recent schedule slips in the TF fabrication, indicate that final development of the remaining CS assembly tasks will take longer than the present schedule, especially if additional prototypes are built. The project should support additional prototyping to reduce technical risk.**
- **Many processes are being developed as the project progresses. Both formal and informal internal reviews of these procedures should continue to ensure thoroughness before proceeding with critical processes.**



Comments (cont'd)

- **While numerous improvements to NSTX hardware and much of the diagnostic relocation, reinstallation, and calibrations are not part of the upgrade project a comprehensive facility readiness plan should be developed. Discussion of this should be presented at the next review.**
- **Recent vendor problems with the NBI port weldment and the TF quadrant mold case has led to a management review of QA inspection for vendor progress and delivered parts. The lessons learned are being applied to all aspects of the remaining procurement. Prompt inspection and testing of hardware upon arrival will be performed and a full time QA person has been provided to assure this is done. Additional opportunities should be explored for verification of vendor performance prior to final delivery.**

Comments (cont'd)

- **The Digital Coil Protection System has fallen behind schedule. At the May 2012 review, the software FDR was scheduled for July 2012 but both the software and hardware PDRs are now scheduled for Q1-FY13. Forecast completion of this task is July 2014, making this very close to critical path. Adequate personnel should be assigned to get this task back on schedule and strong consideration should be given to advance this task.**



2. Technical Status

Kellman, GA*/Oren, TJNAF/Strauss, DOE/SC

Recommendations

- **Develop a comprehensive facility readiness plan and schedule including both project and non-project items. Present plan at the next review.**
- **Assign adequate personnel to assure completion of the Digital Coil Protection System on the original baseline schedule.**



Charge Questions:

2. Are the current project cost and schedule projections consistent with the approved baseline cost and schedule? **Yes.**

Is the contingency remaining adequate for the risks that remain?

Generally yes.

4. Has the Integrated Project team implemented all required actions in the Corrective Action Plan that was developed following the Project Status review from May 2012? **Yes**



Findings

As of October 31, 2012		
Project Type	MIE	
CD-1	Planned: Dec 2009	Actual: Apr 2010
CD-2	Planned: Dec 2010	Actual: Jan 2011
CD-3	Planned: Jan 2012	Actual: Dec 2011
CD-4	Planned: Sep 2015	Actual: on schedule
TPC Percent Complete	Planned: 50.7%	Actual: 53.4%
TPC Cost to Date	\$44.3.0M	
TPC Committed to Date	\$46.1M	
TPC	\$94.3M	
TEC	\$83.5M	
Contingency Cost (no Mgmt Reserve)	\$11.8M	
Contingency Schedule on CD-4	12 mths (baseline)	55.6% to go
CPI Cumulative	1.00	
SPI Cumulative	1.06	



Findings (con't)

- The project critical path is through the TF coils, the center stacks, digital coil protection, and vessel closure and pump down.
- **The project standing army cost is ~ \$250K per month.**
- The project performs a bottom-up estimate every six months with the last estimate performed in July 2012.
- **Since the May 2012 review, four months of schedule float has been utilized for magnet activities.**
- **The project has used ~\$5.7M of cost contingency since CD-2, with majority of this contingency usage resulting from magnet related activities.**
- Since the last review the project has discovered that 4 TF coils had some damage. Two will be repaired and two will be replaced.



Comments

- The current project cost and schedule projections are consistent with the approved cost and schedule baseline.
- The utilization of **four months of schedule float in the past six months along with the amount of cost contingency associated with the magnet activities is a concern. However, the committee judged that that contingency remaining is adequate for the remaining risks.**
- The Integrated Project Team has implemented the cost and schedule actions in from the May 2012 review.



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Recommendations

- None



Charge Questions

1. Construction Efforts: Are construction efforts being executed safely? **Yes**
Does the project have adequate resources and the appropriate skills mix to execute the project per the plan? **Yes, but is at risk of losing critical skills and key personnel if program funding is reduced.**
3. Management: Evaluate the management structure as to its adequacy to deliver the scope within budget and schedule. Are risks being actively managed? **Yes.**
4. Response to Prior Reviews: Has the Integrated Project Team implemented all required actions in the Corrective Action Plan that was developed following the Project Status review from April 2012? **Yes.**



- **Findings**

- The Integrated Project Team has been stable since baseline approval and authorization to begin construction.
- The Project is forecasting two month accelerated early finish relative to the baseline early finish.
- The Project lost 4 months of float since May 2012 due to technical, design and vendor issues.
- Procurements are generally proceeding well; critical vendors are delivering mostly to plan. There were problems but these have been corrected and lessons have been learned.



- **Findings**

- Fabrication of major technical components (center stack, neutral beam, ancillary systems) is making good progress with some technical complications that are being well managed.
- The project is entering a risky phase to fabricate major components of the center stack.
- Installation and construction reports excellent progress. Dis-assembly is complete and re-assembly is beginning.
- There are no project related recordable injuries or radiological incidents to date.
- The University Advisory Committee visited in October and reviewed the project along with other programs at the lab. There were no project sponsored peer reviews since CD-3.



- **Findings**
 - The Project, Lab, Site Office and Program have agreed to funding guidance and planning assumptions.
 - There may be indirect impacts to the project resulting from possible funding reductions by the Program at the Lab.



- **Comments**
 - The project has performed very well since CD-3 as measured by EVMS data.
 - The project appears on a track to successful early completion based on performance to date, remaining cost and schedule contingencies, and risk analysis.
 - Installation and construction appear very well planned and executed so far.
 - Safety performance is good.
 - A more detailed plan to assure facility readiness for operation, acceptable to by the Site Office, is needed.
 - The combined impacts of risks related to loss of critical skills and key personnel appear to be overly optimistic.



- **Comments**

- Proposed impacts to the project from the President's FY 2013 budget and out-year program guidance have been analyzed and are mostly understood considering funding uncertainties.
- There is a comprehensive strategy, agreed to by the Lab, Site Office, and Program to address the funding uncertainties.
- The Program, Lab, Project and Site Office should continue to evaluate all impacts to the baseline from potential changes to funding profiles once these are better understood and communicated by the Program.



- **Recommendations**
 - Reassess the potential impacts of the loss of critical skills and personnel and update the risk registry by February 1, 2013.
 - Prepare a plan for startup readiness that is acceptable to by the Site Office prior to the next review.