NCSX
National Compact Stellarator Experiment

NCSX Risk Management

Assessment, Mitigation, and Resolution

Wayne Reiersen

SC Project Review

PPPL

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Risk Management

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- Mechanisms are in place and being effectively used by the project to manage risks
- Good progress has been demonstrated resolving risks identified at the previous SC Project Review
- Appropriate mitigation plans are in place for the remaining risks that have been identified
- The budget and schedule contingency are adequate to manage future risks

Good progress made resolving previously identified risks

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- WBS 12. VVSA procurement cost
  - Concern that that costs could rise in spite of the fixed-price procurement due to project-directed changes
  - $431K price increase as a result of a misunderstanding in the bid and award process for which the project assumed responsibility (Viola)
  - No major technical problems or other significant cost increases have occurred

- WBS 12. VV final assembly weld
  - Concern about weld distortion during final assembly
  - Weld R&D tests successfully demonstrated a workable solution for the joint design (Nelson)

Good progress made resolving previously identified risks

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- WBS 12. Completion of VV final design.
  - The concern was that the work would not get done in a timely manner.
  - Steady progress has been made (Nelson)
    - FDRs have been conducted for the heating/cooling tubes, VV supports, thermal insulation, and personnel access port
    - Design basis analyses have been documented and checked
    - Drawings to support procurement and fabrication activities have been developed and are being checked.
    - The heating/cooling tubes are being re-designed with flexible tubing after receiving no bids for forming hard tubing.
  - Remaining work has been included in FY06 plans. $204K of budget added for VV final design and Title III engineering as part of ECP39.

Good progress made resolving previously identified risks

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- WBS 13. TF coil procurement
  - Concerns existed about the whether interested domestic suppliers could be found who could fabricate the coils to the high quality requirements necessary
  - As a result of a 'make or buy' study, it was decided to build the TF coils in-house by experienced fusion engineers and technicians sensitive to NCSX quality requirements

- WBS 14. Material properties of the cable conductor
  - Concerns existed about the mechanical properties of the cable conductor being adequate for service at full parameters
  - The R&D program for characterizing the mechanical properties of the cable conductor has been completed. The properties appear adequate for service at full parameters. (Nelson)

Good progress made resolving previously identified risks

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- WBS 14. Modular coil winding pack cooling
  - There were concerns that the baseline design (heat conducted to outer LN2 cooling pipes via copper cladding and chill plates) would be difficult and costly to fabricate and would not provide adequate performance.
  - Cooling system design was improved. Modified design was implemented on Twisted Racetrack Coil (TRC). No fabrication problems were encountered. TRC testing showed that the cooling system design performed as expected providing adequate performance. (Nelson)

- WBS 14. Service life of the MCWF
  - The concern was the maximum field level or service life may be limited by crack growth.
  - Testing of the MCWF custom alloy by the NHFML was performed. Results indicate that fracture properties are adequate for this application. (Heitzenroeder)

Good progress made resolving previously identified risks

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- WBS 14. MCWF procurement cost and schedule
  - Concern existed that costs and delivery schedule could grow in spite of fixed-price and -schedule procurement.
  - There have been no requests for additional funding to complete the original scope. The contract cost has grown by $33K (0.4%) after completing 45% of the work.
  - Steady progress in the production of the winding forms has been made but at a slower rate than originally planned (Heitzenroeder)
  - The project can accommodate the delivery schedule we realistically expect (Neilson, Heitzenroeder)

Good progress made resolving previously identified risks

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- WBS 14. Completion of modular coil final design
  - The concern was that the work would not get done in a timely manner.
  - Design of the Type C assembly is now complete.
  - Design of the Type A and B coil assemblies is underway. The design changes and techniques developed for the Type C assembly are directly applicable.
  - Remaining work has been included in FY06 plans. $520K of budget added for modular coil final design and Title III engineering as part of ECP39.

Good progress made resolving previously identified risks

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- WBS 82. Dimensional control and metrology
  - Dimensional control requirements are more stringent and pervasive than on previous experiments.
  - Brent Stratton brought on board as the project's dimensional control coordinator
    - A dimensional control plan (DCP) was developed for winding the modular coils based on our experience winding the TRC and R&D for stabilizing the winding pack
    - Dimensional control plans will also be developed for field period assembly and machine assembly.
  - Steve Raftopoulos has been identified as the lead metrology engineer
    - A new Romer arm with scanning software has been delivered
    - Training has been provided to the coil technicians
    - Experience gained on fabricating the TRC
    - Training is planned for the Leica laser tracker which will be used along with the Romer arms during field period assembly.

Good progress made resolving previously identified risks

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- WBS 18. Modular coil assembly fixture
  - A design for a modular coil assembly fixture which would be used to slide a 3-coil module of modular coils over a half-period of the vacuum vessel was sent out to industry for review and for budgetary cost estimates. The estimates received indicated it was unaffordable.
  - Project pursued two paths – [1] building the assembly fixture in house and [2] using the O/H crane in the TFTR TC to provide x-y-z motion and to hang the 3-coil module using 3 hydrosets to provide the appropriate tilts. This second approach was significantly cheaper and was successfully tested and adopted as the baseline.

Mitigation plans are in place for remaining risks

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- WBS 12. VV thermal insulation
  - The project adopted an insulation design with pourable insulation to fill the annulus between the VV and MC shell because it provided better performance at reduced cost relative to the Microtherm blanket option. Final selection of a pourable insulation compatible with 350C operation still needs to be made. (Nelson)
  - Several candidates have been identified including perlite and glass microspheres. Nanogel pellets without the flammable coating are another possibility. Samples will be procured and tested in FY06.

Mitigation plans are in place for remaining risks

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- WBS 13. TF wedge castings
  - There was only one response to the RFP and it far exceeded the $200K budgeted
  - The project is considering 5 options for mitigating this cost risk
    - Revising the tolerance specification to reduce the machining cost.
    - Building a prototype to reduce the supplier's cost uncertainty.
    - Revising the stainless steel material specification to open up the pool of interested suppliers
    - Using of alternate materials such as aluminum bronze which might be cast to near net shape and dramatically reduce machining costs
    - Having the wedge castings produced in China through collaboration with ASIPP

Mitigation plans are in place for remaining risks

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- WBS 13. TF coil fabrication cost
  - The estimate to complete (ETC) for fabricating the TF coils has grown with the completion of final design and a more detailed understanding of the fabrication process. More time and resources are required than previously anticipated.
  - Additional time and resources were added to the baseline via ECP39. The budget was increased by $432K. This fully covers completion of the TF winding facility, materials costs, and fabrication of the 1st TF coil (which is all the work planned for FY06)
  - A process improvement goal to reduce the labor hours required to fabricate the TF coils was set at 10%.
  - The projected cost and schedule to fabricate the balance of TF coils will be re-assessed after the first coil is produced.

Mitigation plans are in place for remaining risks

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- WBS 14. Modular coil winding fabrication cost
  - The estimate to complete (ETC) for winding the modular coils has grown as a result of experience in winding the Twisted Racetrack Coil (TRC). More time and resources are required.
  - Completion of the first three modular coils (through Q3 FY06) is fully covered within the existing budget.
  - A process improvement goal to reduce the labor hours required to fabricate the modular coils was set at 10%.
  - The projected cost and schedule to fabricate the balance of modular coils will be re-assessed after the first three coils produced.

Mechanisms for managing risk

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- Numerous mechanisms are in place and effectively used by the project for managing risk
  - Implementing good procurement management practices
    - Close oversight of supplier activities
    - Win-win management approach
    - Timely review of in-process QA documentation
    - Tight control of requirements and design changes
  - Promoting design and process improvements
  - Optimizing procurement strategies (e.g. make or buy analysis)
  - Performing R&D or prototyping
  - Re-visiting requirements (e.g. value engineering)
  - Re-planning activities (e.g. 2-shift operation)
  - Increasing resources (e.g., augment designer staff to expedite MC design completion)

- Having adequate contingency is essential for implementing these mechanisms

Remaining contingency is adequate for the work to go

	BCWR	Contingency	%
12 - Vacuum Vessel (w/o VVSA)	863	209	24%
VVSA Contract	2,392	240	10%
13 - Conventional Coils	3,316	1,268	38%
14 - Modular Coils (w/o MCWF)	8,086	2,323	29%
MCWF Contract	4,499	450	10%
15 - Structures	1,308	391	30%
16 - Coil Services	1,135	341	30%
17 - Cryostat and Base Support Structure	1,162	347	30%
18 - Field Period Assembly	3,945	1,179	30%
19 - Stellarator Core Mgt & Integration	1,283	128	10%
1 Stellarator Core Systems	27,989	6,876	24.6 %
2 Heating, Fueling & Vacuum Systems	443	62	14%
3 Diagnostics	744	176	24%
4 Electrical Power Systems	2,779	549	20%
5 Central I&C	1,840	187	10%
6 Facility Systems	654	131	20%
7 Test Cell Prep & Mach Assembly	3,667	793	22%
8 Project Oversight & Support	6,285	839	13%
Subtotal	44,401	9,612	21.6 %

- Contingency requirements were re-assessed at the activity level
- A budget contingency of $9612 (22%) is adequate
- Reflects increased design maturity – resolution of past risks and a better understanding of future scope and risks
- Schedule contingency of 5 months is also adequate

Summary

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