The NCSX Critical Issues Tracking List
May 10, 2004

The NCSX critical issues tracking list is the key implementing vehicle for the project's risk management plan. The plan is described in the project document "NCSX Risk Management Plan, Rev 0," NCSX-PLAN-RMP-00.[1] Global risks (e.g, possibility of an operational failure resulting from design or fabrication defects, cost and schedule overruns) were identified in the project's baseline documentation for CD-2. The identification and mitigation of risks in each subsystem is the responsibility of that subsystem's WBS manager. Risk management is addressed in the Design Description Documents for each subsystem. The critical issues list is a living document which the System Integration Team (SIT) uses as a tool to ensure management visibility of, and attention to, those risks, regardless of subsystem, that pose high cost, schedule, or technical threat to the project's success.

At any given time, critical issues on the list are classified in one of three categories: Category I (issue recognized, mitigation plan being developed); Category II (mitigation plan implemented, issue being addressed but requires attention); Category III (issue retired, or being satisfactorily addressed and tracked through routine project control proces.) Typically an issue first appears under Category I and subsequently moves to Category II and eventually Category III, where it filed for historical purposes. The critical issues list is reviewed by the SIT at weekly meetings, where mitigation plans are developed and follow-up actions are taken to be sure that these issues are receiving due management attention.

---

[1] Posted at http://ncsx.pppl.gov/Systems Engineering/Plans Procedures/NCSX_Mgmt Plans/RMP/NCSX_PLAN_RMP-00.pdf

WBS	ID	Situation	Risk	Type	Mitigation Plan	Status
14 - Modular Coils	14 -9	**Modular coil winding pack cooling. The baseline design (heat conducted to outer LN2 cooling pipes via copper cladding and chill plates) satisfies requirements but may be difficult and costly to fabricate and may extend the critical path.**	Cost and schedule of winding pack fabrication.	Cost Schedule Technical	1. Use the winding pack manufacturing development program (twisted racetrack and full-scale prototype) to address fabrication issues with the baseline design. 2. Pursue alternate designs with improved fabricability features. Test it on the twisted racetrack (e.g., one side of the tee.) Any backup design must stay within established envelopes, especially the MCWF and VVSA designs.	**1. Review manufacturing development plan for the windings, including the twisted racetrack coil, to be sure it adequately addresses the issues of concern with the baseline design, and modify plan if necessary. (J. Chrzanowski) 2. The plan may devote some fraction of the resources to developing a backup design with improved fabrication characteristisc. If so, a decision process is needed. A backup design concept was proposed and discussed at one meeting.**
81 - Project Management	81-1	**Procurement costs of MCWF and VVSA will be uncertain until production proposals are received. If the prices significantly exceed current estimates, it will impact the project cost and schedule baselines. The impact and any workarounds need to be determined prior to CD-3. There is not much time to come up with a get-well plan between receipt of proposals and approval of CD-3.**	If MCWF or VVSA costs significantly exceed current estimates, the schedule may be impacted because the project budget profile (flat in FY-05) provides little or no cash flow flexibility. Either those procurements will have to be stretched out, other procurements (e.g. TF or PF) will be delayed, or in-house coil winding and field-period assembly activities will be slowed.	Cost Schedule	Prepare for worst-case price proposals by performing some what-if analyses with the project's cost and schedule data base to assess various options for handling a large increase in the MCWF/VVSA costs. Identify cost, schedule and resource impacts and, with PPPL and ORNL management, develop possible solutions for minimizing the impact on the project.	**1. What-if analyses have started.**

WBS	ID	Situation	Risk	Type	Mitigation Plan	Status
13 - Conventional Coils	13-1	**Procurement plan.** There is no procurement plan for the Conventional Coils. There is concern about whether a pool of qualified and interested domestic suppliers even exists.	If no domestic suppliers exist, the cost and schedule for procuring the conventional coils may beat risk.	Cost and schedule	Kalish to investigate domestic capabilities and interest and propose procurement plan based on his findings.	**A list of potential vendors has been compiled and we are contacting these vendors directly to determine viable prospects. These direct contacts with suppliers are increasing our confidence that qualified suppliers will be available. As a fallback position, coils could be fabricated in-house at PPPL if necessary**
14 - Modular Coils	14 -1	**Material properties, design criteria, and design margins**. Reference material properties and design criteria for the cable conductor have not been finalized. Holes (cyclic testing) and indeterminate results (cure strain) need to be addressed.	Failure of the conductor if stresses/strains are too high	Technical	Original plan was as follows: 1. Draft SOW to define additional R&D required. (Nelson) 2. Perform additional R&D required to establish design allowables (Chrzanowski) 3. Document reference material properties based on data in hand now. Update when additional R&D is completed. (TBD)	**Test plan is being executed. Compression, flexure, and tension properties have been measured. Fatigue tests Are underway. Design criteria for cable conductor have been drafted. Analyses of the MCWF and winding pack have been performed but need to be repeated with latest property information. Progress thru mid-May is sufficient to support the FDR of the MCWF. Fatigue testing and update of analyses (primarily for the winding) will finish after the FDR.**

WBS	ID	Situation	Risk	Type	Mitigation Plan	Status
14 - Modular Coils	14-2	**Modular coil deflections**. Modular coil deflections due to differential thermal strain (between the winding and tee) and deflections under load are not accommodated in our tolerance budget, which is nominally 0.5mm each for winding, FP assembly, and final assembly.	Performance could be compromised if the deflections give rise to substantial islands.	Technical, schedule	Determine if modular coil deflections give rise to substantial islands (Strickler)	Peer review of tolerances and field errors on April 21 showed that predicted coil deflections, which preserve strellarator symmetry, are tolerable in terms of field errors. Need to verify that this is a general results and establish tolerances fo rdeflections under load.
	14-6	**Local high permeability zones**. Local high permeability zones are likely to result from weld repairs in the MCWF. Prudent acceptance critieria need to be established.	Field errors that impact plasma performance if the criteria are too liberal. Cost (an schedule) if criteria are too stringent.	Technical, cost, and schedule.	Model the effects of local high-mu regions on the MCWF on islands to develop an acceptance criterion for nonconformances. (Brooks)	**Work is in progress**
82 - Systems Analysis	82-3	**Metrology**. Metrology is critical to building the stellarator to the required tolerances. Metrology requirements are more stringent and pervasive than on previous experiments.	The risk is that we will not be able to fabricate and assemble the device to the required tolerances in the time allotted.	Technical, cost, and schedule	An initial assesment of the complement of metrology equipment required has been compiled. A new Romer arm with scanning software has been ordered. A task has been added to optimize and document coil alignment. This task explicitly includes modeling of metrology to determine required process to meet assembly tolerances, including visibility issues. Engineers and technicians need to becomed trained in the use of our suite of metrology equipment.	Romer arm, with laser scanning attachment and software to compare with CAD model, has been received. A successful method for comparing inspection data with design models has been demonstrated on the first prototype vacuum vessel sector (PVVS). A plan has been developed for in-house measurement of the PVVS which will gain experience with the new equipment.

Category III

WBS	ID	Situation	Risk	Type	Mitigation Plan	Status
12 - Vacuum Vessel	12-1	**Plasma-FW clearance.** Less space exists between the first wall and plasma than previously existed.	Inadequate plasma performance, especially in divertor operation	Technical	1. Expand the VV by pushing it out locally where we lost space. Pass data to ORNL to rebuild the VV shell (Brooks). 2. Rebuild VV shell (Nelson). 3. Check final shell geometry for clearances during FP asembly (Brooks) and final assembly (Brown). 4. Redefine a FW boundary for Physics (Brooks).	Loss of space tracked to change in VV representation. Geometry has been updated by Brooks and passed back to ORNL. Interferences resolved. Updated FW geometry supplied to Physics following 2/18 WBS 1 telecon.
12 - Vacuum Vessel	12-2	**Port geometry.** Port geometry needs to be finalized in order to proceed with final design. Inadequate clearances are know to exist.	Inadequate access for diagnostics and heating systems if port geometry is defined incorrectly. Inadequate time to complete final design if port geometry is not defined soon enough. Hard interferences would preclude assembly. Soft interferences would result in excessive local heat leaks.	Technical, schedule	1. Finalize "road map" of port sizes and allocations (Cole). 2. Resolve interferences, preserving ample (zero risk) clearances during all conditions [field period assembly, bakeout with coils warm, bakeout with coils cold, RT operation with coils cold. etc.]. (Cole) 3. Finalize port sizes (Cole).	1. Port sizes, orientations, and allocations are being worked with Diagnostics. 2. Port allocations for inboard ICH are being resolved. 3. Interferences are being resolved. Successful series of peer reviews concluded. All configuration issues resolved; diagnostics and RF access requirements satisfied. April, 2004
12 - Vacuum Vessel	12-3	**Completion of final design**. There are many tasks that need to be completed for final design including the development of drawings and specifications; documentation of design basis analyses (and their checks), interfaces, assembly plans, etc.	The procurement could be delayed. Technical scope not documented at the FDR may not be subject to independent review.	Schedule	Develop a comprehensive list of deliverables for final design. Stagger the due dates evenly between now and the FDR. Use completion of deliverables as an objective metric to monitor progress towards completion of final design.	May, 2004: Documentation and presentations addressing all technical and documentation issues are being prepared for the FDR.

Category III

WBS	ID	Situation	Risk	Type	Mitigation Plan	Status
12 - Vacuum Vessel	12-4	**Electropolishing**. Electropolishing the vacuum vessel - is it required or not? Costs and benefits need to be clarified.	If yes: cost, currently estimated to be $100-150K. Roughly 5% of the VVSA cost. Schedule: about 6 weeks on the VVSA schedule. Increases cost & schedule risk in the VVSA procurement due to increased complexity. No spec. If no: concern that mechanical polishing might not produce a good enough surface for high vacuum operation.	Technical, cost, Schedule	Clarify cost & schedule risks. Clarify technical benefits by compiling recommendations from experts and making a judgement.	Electropolishing requirements established by Neilson.
12 - VV 3 - Diagnostics	12-5	**Port adapters.** Who owns the port adapters (including the cryostat penetration and boots) beyond the first flange? VV or Diagnostics? First flange will be inside the cryostat in many cases, to allow greater flexibility in the design of the port adapters for diagnostic access.	If VV owns them: No requirements exist. Probably very costly. If Diagnostics owns them: it means that we will be making frequent modifications to the cryostat design. May mean starting over with the crystat design concept. Increases diagnostic costs.	Mgmt	Engineering work the interface issues with both work packages and make a recommendation. (Reiersen)	**Initially, straight extensions will be provided by WBS 12 through the cryostat. Diagnostics is responsible for any changes thereafter.**
14 - Modular Coils	14-7	**Modular coil interferences.** Interferences exist between Type A - to - Type A modular coils during field period assembly.	Inability to assemble modular coils over the vacuum vessel.	Technical	Enlarge pockets to receive the windings to allow additional motion. Optimize assembly trajectory to relieve interferences with this additional freedom. Modify shape of VV shell as a last resort. Final geometry should be checked with a stereolithography model.	**Brooks reported at 2/18 WBS 1 telecon that this problem was resolved.**

WBS	ID	Situation	Risk	Type	Mitigation Plan	Status
	14-8	**Completion of final design**. There are many tasks that need to be completed for final design including the development of drawings and specifications; documentation of design basis analyses (and their checks), interfaces, assembly plans, etc.	**Past history (all WBS elements)**. A comprehensive list of deliverables is never generated. Due dates are all just prior to the scheduled design review date. Deliverables are not provided. We threw things over the wall from PD into FD. We cannot do that for FD.	Schedule	Develop a comprehensive list of deliverables for final design. Stagger the due dates evenly between now and the FDR. Use completion of deliverables as an objective metric to monitor progress towards completion of final design.	May, 2004: Documentation and presentations addressing all technical and documentation issues has been prepared for the FDR.
82 - Systems Analysis	82-1	**Structural steel in TC**. The NCSX Test Cell has quite a bit of structural steel around the machine.	The structural steel could introduce field errors and consequently islands in the plasma	Technical	Assess magnitude of field errors from structural steel (Brooks)	Work has been completed. The error fields have been calculated and are expected to be around 10 gauss. These fields are largely vertical and should be trim-able (if necessary) with the PF and external trim coils.
	82-2	**Systems Analysis tasks**. We are getting behind the wave in completing our systems analysis tasks. These include: Develop filament model of Pro/E coils, look at surface quality and phsyics performance Assess impact of coil deflections (thermal, EM) Resolve interferences related to FP assembly, finalize MC and VV shell geometry Investigate "best fit" issues for optimal assembly Assess the impact of magnetic materials in the test cell Evaluate eddy current heating in the VV and cold mass Local high permeabilty zones criteria Seismic analysis plan	There are two risks: [1] The tasks will not be competed by the time they are needed. [2] We do not (and will not) have the budget to support completion of these tasks.	Technical, cost, and schedule	**Meeting held on 1/16. Tasks identified. Resource requirements and schedule identified.**	Activites will folded into the WAFs. **Closed.**

Category III

WBS	ID	Situation	Risk	Type	Mitigation Plan	Status
	82-4	**Review of VV and MC Final Designs**. The FDRs for the VV and MC will likely be combined into a single, external review in order to expedite CD-3 approval. External reviews, while valauble and necessary, do not satisfy internal review requirements.	Internal reviews, with more comprehensive and stringent standards, are required to convince ourselves that we are ready to proceed with fabrication of the VVSA and MCWFs.	TCS	Plan on combining the VV and MCWF FDRs. Conduct a series of peer reviews in advance of the formal (external) FDR that covers the full technical scope of an internal FDR.	**FDR Plan adopted with MCWF and VVSA combined in a single review.** **Peer reviews condcuted in advance to assure readiness for May '04 FDR**