

NCSX Risk Register

No.	Affected Jobs	Risk Description	Mitigation Plan	Likelihood of Occurrence ^a	Consequences	Risk Class	Basis of Estimate	Cost Impact (\$k)		Schedule Impact (mos)		Responsibility
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1	1354 7503	Additional trim coils may be required to suppress field errors from n>1 modes	Analysis being performed to firm up requirements	U	Marginal	Low	Costs could more than double the present estimate	+\$200	+\$400	+ 0.00	+ 0.00	Determine if additional trim coils need to be in MIE or if the configuration must accommodate a specific future set of coils [Zarnstorff]
2	1361	TF vendor produces a non-compliant coil requiring fabrication of an additional coil	Conductor for extra coil already procured. Ample float in schedule to avoid critical path impact.	VU	Negligible	Low	Increase PPPL Title III by ~1 man-month	+\$15	+\$35	+ 0.00	+ 0.00	No additional action required [Kalish]
3	1352	PF vendor produces a non-compliant coil requiring fabrication of an additional coil	Conductor for extra coil will be procured in advance and available to wind a new coil if required. Float in schedule appears adequate to avoid critical path impact.	VU	Negligible	Low	Increase PPPL Title III by ~1 man-month	+\$15	+\$35	+ 0.00	+ 0.00	Implement mitigation plan [Kalish]
4	1421	Modular coil interface design needs to change significantly from the baseline for unforeseen technical reasons	Task forces formed to expedite resolution of feasibility issues. Development activities are underway.	VU	Critical	Moderate	Design of the MC interface is on the critical path. Potential impacts include [1] additional design and development (4 engineers for 1-2 months) plus \$100K M&S and [2] a change in the cost of field period and final assembly to a change in the design (+/- \$300K).	(\$100)	+\$600	+ 1.00	+ 2.00	Expedite completion of modular coil interface design. Complete preliminary design ASAP. [Williamson]
5	1421 1810	As a result of the development trials for weld distortion, the welding time increases significantly above present allowance	Welding time estimates consistent with time requirements for first R&D article which appeared to have very low distortion. Risk goes away at conclusion of ongoing weld R&D.	U	Significant	Moderate	Nominal welding time may double. Estimate based on \$300K/mo for FPA activities.	+\$0	+\$600	+ 0.00	+ 2.00	Monitor welding time during development trials. Consider process improvements to minimize welding time w/o introducing additional distortion. [Viola]
6	1451	Damage or loss of modular coil during VPI or testing requiring the conductor to be stripped off and re-wound	Continue to use same rigorous process used for first 12 coils during which there were no fabrication mishaps requiring re-winding a coil	U	Significant	Moderate	~\$35K in materials; ~\$380K in labor. 7.5 months to do work with the potential for a 2 month impact on the critical path.	+\$400	+\$450	+ 0.00	+ 2.00	Continue following mitigation plan [Chrzanowski]
7	1451	Failure of major piece of winding equipment (e.g., motor, gear box, etc.) resulting in extended downtime in a winding station	Use three remaining winding stations to continue MC fabrication while fourth station is being repaired	U	Negligible	Low	~\$10K for equipment plus repair costs	+\$10	+\$30	+ 0.00	+ 0.00	Implement mitigation plan if needed [Chrzanowski]

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8	1810 7503	"Back office" support for FPA and final assembly becomes a chronic bottleneck, stretching out the time required to complete assembly operations	Additional support budgeted for Brown, Brooks, and Ellis providing "2 deep" back office support. Should be available to mitigate peak demands once training in key skills is completed.	VU	Significant	Low	Estimated impact is <2 months on the critical path. Cost impact covers up to 2 months of FPA/final assembly.	+\$0	+\$600	+ 0.00	+ 2.00	Identify backup personnel for "two deep" back office support [Heitzenroeder] Provide training when backup personnel are assigned [Brown, Brooks, Ellis]
9	1810	Modular coil damaged during assembly requiring significant rework to coi	Equipment will be handled during FPA using carefully constructed procedures to minimize likelihood	VU	Negligible	Low	Nominally repaired with a 2-man crew within 2 weeks	+\$10	+\$20	+ 0.00	+ 0.50	Include provisions to guard against coil damage in FPA procedures [Viola]
10	1810	VV surface component (coolant tube, flux loop, or TC) damaged during FPA requiring significant rework	Equipment will be handled during FPA using carefully constructed procedures to minimize likelihood	VU	Negligible	Low	Nominally repaired with a 2-man crew within 2 weeks	+\$10	+\$20	+ 0.00	+ 0.50	Include provisions to guard against coil damage in FPA procedures [Viola]
11	1810	Unacceptable distortion in a field period when welding modular coil shims requiring rework	Likelihood of occurrence is very unlikely as a result of extensive welding R&D and careful monitoring during welding.	VU	Marginal	Low	Cut apart and re-weld two coils back together. Nominally a 2.5-man crew in 12 weeks.	+\$25	+\$35	+ 0.75	+ 1.25	Develop suitable weld procedures and train welders to minimize likelihood of unacceptable distortion [Viola]
12	1810	Field period damaged during loading, transport, or unloading from TFTR TC to NCSX TC	Extreme care will be taken when transporting a field period. Additional reviews including external reviewers will be performed.	NC	Crisis	Low	<i>High impact-low probability event not covered by contingency</i>					Develop appropriate procedures for transporting field periods. Arrange for a peer review of the procedures prior to transporting the first field period. [Viola]
13	1815	Multiple vacuum leaks during initial pumpdown	Welds will be leak checked during FPA when leaks can be addressed without significantly impacting the critical path. Likelihood of many leaks appearing during initial pumpdown is considered extremely unlikely with this mitigation plan.	NC	Marginal	Low	Impact of having only a few leaks is covered in estimate uncertainty with present mitigation plan					Implement mitigation plan [Viola]

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14	7503 1810 1352 1361	Insulation on TF/PF coil fails during initial cooldown and testing requiring in situ repair	<p>1st of each kind will be tested at cryogenic temperature at elevated (50% higher than routine field tests) voltage for faults to ground. All coils will be tested at RT at elevated (50% higher than routine field tests) voltage for faults to ground. Ring tests are performed to reveal low resistance turn-to-turn shorts at RT. These tests will be performed as part of the mfg acceptance testing.</p> <p>In addition, routine field tests will be performed on each assembly station to ensure that the electrical insulation was not compromised during assembly operations.</p>	VU	Marginal	Low	Insulation fault in lead area is considered the most likely failure scenario. Repair in situ is assumed recovery scenario taking 2-3 months. 1 month to warmup and cooldown the stellarator core. 3 techs/1 engr for duration of active repair)1-2 months).	+ \$50	+ \$150	+ 1.00	+ 2.00	Implement mitigation plan during TF/PF fabrication [Kalish] and field period and final assembly [Viola, Perry]
15	7503 1810 1352 1361	Insulation on TF/PF coil fails during initial cooldown and testing requiring dismantling stellarator core	<p>1st of each kind will be tested at cryogenic temperature at elevated (50% higher than routine field tests) voltage for faults to ground. All coils will be tested at RT at elevated (50% higher than routine field tests) voltage for faults to ground. Ring tests are performed to reveal low resistance turn-to-turn shorts at RT. These tests will be performed as part of the mfg acceptance testing.</p> <p>In addition, routine field tests will be performed on each assembly station to ensure that the electrical insulation was not compromised during assembly operations.</p>	NC	Crisis	Low	High impact-low probability event not covered by contingency					Implement mitigation plan during TF/PF fabrication [Kalish] and field period and final assembly [Viola, Perry]

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16	7503	Insulation on modular coil fails during initial cooldown and testing requiring in situ repair	C1 tested at full current at cryogenic temperature. All modular coils will be tested at RT at elevated (50% higher) voltage for faults to ground. In addition, routine field tests will be performed on each assembly station to ensure that the electrical insulation was not compromised during assembly operations.	VU	Marginal	Low	Insulation fault in lead area is considered the most likely failure scenario. Repair in situ is assumed recovery scenario taking 2-3 months. 1 month to warmup and cooldown the stellarator core. 3 techs/1 engr for duration of active repair)1-2 months).	+\$50	+\$150	+ 1.00	+ 2.00	No additional action required
17	7503 1810 1451	Insulation on modular coil fails during initial cooldown and testing requiring stellarator core disassembly	C1 tested at full current at cryogenic temperature. All modular coils will be tested at RT at elevated (50% higher) voltage for faults to ground. In addition, routine field tests will be performed on each assembly station to ensure that the electrical insulation was not compromised during assembly operations.	NC	Crisis	Low	<i>High impact-low probability event not covered by contingency</i>					Implement mitigation plan during modular coil fabrication [Chrzanowski] and field period and final assembly [Viola, Perry]
18	7503	Unanticipated problems with cryostat penetrations (icing, excessive condensation). May require warming up the stellarator core to effect repair with consequent impacts to critical path activities.	Rapid repair materials will be on hand.	U	Marginal	Low	Nominally repaired with a 4-man crew in 1 week with 3 weeks for warmup/cooldown (if required)	+\$15	+\$30	+ 0.25	+ 1.00	Ensure that repair materials are on hand in case they are needed [Perry]
19		Loss or prolonged unavailability of certain key personnel from the project could substantially impact the schedule.	<i>See mitigation plans for individuals listed below.</i>									
	1901	Mike Cole (ORN)	Brad Nelson is been budgeted (15%) on the project. Should Cole become unavailable, Nelson would step in and handle Cole's responsibilities until a suitable longer term solution was implemented.	VU	Marginal	Low	Estimated impact is <0.5 months on the critical path. No impact on FPA cost because impacted personnel would be assigned to other activities.	+\$0	+\$0	+ 0.00	+ 0.50	Ensure that contingency plan is in place for Mike Cole [Lyon]
	8203	Tom Brown (PPPL)	Bob Ellis has been budgeted along with a designer to provide support to Tom Brown in Design Integration during peak demands and pick up the slack for Brown if he became unavailable.	VU	Marginal	Low	Estimated impact is <0.5 months on the critical path. No impact on FPA cost because impacted personnel would be assigned to other activities.	+\$0	+\$0	+ 0.00	+ 0.50	Provide training as required for Ellis [Brown]

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	8204	Art Brooks (PPPL)	An EA/EM engineer has been budgeted to provide support to Brooks in Systems Analysis and Technical Assurance during peak demands and pick up the slack for Brooks should he become unavailable.	VU	Marginal	Low	Estimated impact is <0.5 months on the critical path. No impact on FPA cost because impacted personnel would be assigned to other activities.	+\$0	+\$0	+ 0.00	+ 0.50	Assign EA/EM engineer as backup to Art Brooks [Heitzenroeder] Provide training to TBD EA/EM engineer [Brooks]
	8205	Bob Ellis (PPPL)	An EA/EM engineer has been budgeted to provide support to Ellis in Dimensional Control Coordination during peak demands and pick up the slack for Ellis should he become unavailable.	VU	Marginal	Low	Estimated impact is <0.5 months on the critical path. No impact on FPA cost because impacted personnel would be assigned to other activities.	+\$0	+\$0	+ 0.00	+ 0.50	Assign EA/EM engineer as backup to Bob Ellis [Heitzenroeder] Provide training to TBD EA/EM engineer [Ellis]
	1802 7401	Mike Viola (PPPL) Erik Perry (PPPL)	Viola and Perry will be cross-trained such that each could do the other's job	VU	Marginal	Low	Estimated impact is <0.5 months on the critical path. No impact on FPA cost because impacted personnel would be assigned to other activities.	+\$0	+\$0	+ 0.00	+ 0.50	Provide required cross-training [Viola/Perry]
20	1803 7503	Assembly sled for final assembly is not adequately stiff or does not provide repeatable motion	Functionality of sled will be determined first with concrete blocks and later with first FP. Ample time to make design modifications between arrival of the first and third FPs.	U	Negligible	Low	Nominal cost impact is 1 man-month of engineering design and up to half the fabrication cost of the sled	+\$25	+\$75	+ 0.00	+ 0.00	Test functionality of sled prior to final assembly [Perry] Modify sled design if needed [Brown]
21	7503	TC floor is not adequately rigid for present metrology plan	Copper sheet and spongy surface removed from TC floor. Fiducials will be placed. Concrete blocks will be placed to see if floor is adequately stiff.	VU	Marginal	Low	Nominal cost impact is 2 man-months of engineering design and \$50-150K for local reinforcement of building structures	+\$50	+\$200	+ 0.00	+ 0.00	Assess adequacy of TC floor [Perry]
22	1810 7503	Modular coils are shorted across toroidal break between field periods causing problematic field errors	Need very low impedance, multiple shorts to get into trouble	NC	Crisis	Low	High impact-low probability event not covered by contingency					Ensure that required electrical breaks are not compromised during field period assembly [Viola] and final assembly [Perry]
23	8101	GPP projects not completed in time to support project needs	The crane and the HVAC systems are the main GPP projects that would need to be completed. The GPP projects have strong Lab and DOE oversight. Ample float is provided in the schedule so project delays due to GPP delays are not considered credible (P<1%).	NC	Crisis	Low	High impact-low probability event not covered by contingency					Continue to monitor progress on GPP projects needed to support NCSX [Perry]

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24	7503 8501	Coils are hooked up with incorrect polarity	Ensure that coils are connected with correct polarity during final assembly. Test during ISTP and fix if necessary	U	Negligible	Low	<i>Covered in estimate uncertainty with present mitigation plan</i>					Ensure that coils are hooked up with correct polarity [Perry]
25	8101	Escalation of Stainless Sheet and Inconel higher than base escalation rates	Funding limits preclude early procurements to avoid escalation impacts	VL	Marginal	Moderate	See separate sheet - assume 3% to 20% higher per year escalation rate	+\$37	+\$266	+ 0.00	+ 0.00	Provide appropriate contingency [Strykowski]
26	8101	Escalation of Copper higher than base escalation rates	Funding limits preclude early procurements to avoid escalation impacts	VL	Negligible	Low	See separate sheet - assume 5% to 20% higher per year escalation rate	+\$11	+\$81	+ 0.00	+ 0.00	Provide appropriate contingency [Strykowski]
27	8101	Labor rates may be significantly lower/higher than projected		L	Marginal	Moderate	Escalation rate may be anywhere in the range of 2-5% instead of the nominal rate of 3.4% for labor. Schedule impact is due to annual funding constraints.	(\$500)	+\$500	(0.50)	+ 0.50	Provide appropriate contingency [Strykowski]
28	1810 1815 7503	Metrology equipment and general purpose tooling/ lifting equipment (e.g. cranes) not available to support the schedule	Maintenance contract mitigates impact of metrology equipment. Additional \$200K budgeted for a 3rd laser tracker and/or spare metrology equipment. Should result in improved efficiency as well as failure mitigation.	U	Marginal	Low	Up to 2 week impact on FPA and critical path. FPA cost impact assumed to be \$300k/mo.	+\$0	+\$150	+ 0.00	+ 0.50	Purchase additional metrology equipment as need becomes apparent [Dudek]
29	1352	No suitable PF coil vendor submits bid. PF coils need to be built in-house	PF is last major, special procurement. Sources sought received two qualified respondents. Capability to build at PPPL (and overseas) exists if needed. Plan developed to expedite PF procurement by 3 months. Plan is under project review.	U	Marginal	Low	Cost impact estimated to be up to \$300k (1/3 of fabrication costs) for potentially higher labor rates at PPPL. No impact on critical path expected.	+\$0	+\$300	+ 0.00	+ 0.00	Expedite completion of PF design to mitigate potential schedule impacts [Kalish]
30	8101	Funding profile may not match assumptions which in turn could impact cost and schedule		U	Significant	Moderate	Cost impact derived from stretchout	+\$0	+\$0	(2.00)	+ 2.00	Provide appropriate contingency [Strykowski]

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31	8101	Overhead rates may change significantly which in turn could impact cost and schedule		U	Significant	Moderate	Overhead rates are determined by institutional funding and are outside the project's control. +/- 2% on the rates are representative of variation in three-year institutional averages over the past 10 years.	(\$900)	+ \$0	(1.00)	+ 0.00	Provide appropriate contingency [Strykowski]

^a VL= Very Likely (P>80%), L=Likely (80%>P>40%), U=Unlikely (40%>P>10%), VU=Very Unlikely (P<10%), NC=Non-credible (P<1%