NCSX
Risk Management Plan

NCSX-PLAN-RMP-01-dF

March 8, 2008

Concurrences:

R. Simmons, Systems Engineering Support Manager

P. Heitzenroeder, Stellarator Core Systems Responsible Line Manager

L. Dudek, Construction Activities Responsible Line Manager

A vonHalle, Electrical Systems Responsible Line Manager

H. Neilson, Project Integration

Approved by: _____

D. Rej, Project Manager

Controlled Document

THIS IS AN UNCONTROLLED DOCUMENT ONCE PRINTED. Check the NCSX Engineering Web prior to use to assure that this document is current.

Record of Revisions

Revision	Date	Description of Changes
Revision 0	2/10/2004	Initial Issue
Revision 1-dA	2/28/2008	Complete re-write to reflect current Project approaches and policies
Revision 1-dB	2/29/2008	Slight modifications to Hutch's re-write.
Revision 1-dC	3/2/2008	Modified Section 3.1 to add discussion of two classes of risk – management & technical.
Revision 1-dD	3/4/2008	Incorporated Gruber comments and added another paragraph to Section 3.1.
Revision 1-E	3/6/2008	Added Technical Risk consequences to Table 3-2 and made minor editorial changes.
Revision 1-F3	3/10/2008	Updated Section 1.3 (Boundary Conditions).

Table of Contents

List of Tables

1. Background and References

1.1 Background

The NCSX Project will manage risks, where "risk" refers to factors within the Project's control that both threaten and provide opportunities to improve project cost and schedule performance and the achievement of project technical objectives. During all phases of the NCSX project, priority is placed on identifying and mitigating risks. Risk mitigation activities are incorporated into the project's cost and schedule baselines, as appropriate. Contingency is used to address realized risks. A quantitative, probabilistic analysis of outstanding risks and estimating uncertainties is used to estimate the amount of contingency required.

Control of the environment, safety, and health hazards, while part of risk management in a broader sense, are not unique to the NCSX Project and are enveloped by the Princeton Plasma Physics Laboratory (PPPL) Integrated Safety Management (ISM) program that is applicable to all PPPL projects and operations. The PPPL ISM clearly indicates that risk management is everybody's business and will be factored into every project decision throughout the life of the NCSX Project.

1.2 References

The DOE Order on Project Management (DOE Order 413.3) emphasizes the importance of risk management from a graded approach perspective. As outlined in the *NCSX Project Execution Plan* (NCSX-PLAN-PEP), the *NCSX Systems Engineering Management Plan* (NCSX-PLAN-SEMP) and the *Configuration Management Plan* (NCSX-PLAN-CMP) risk management is the driving force in establishing and for maintaining the technical, cost, and schedule baselines for NCSX. In addition, PPPL Engineering Procedure, *ENG-032, "Work Planning*," provides the lab's overall guidance in establishing project requirements based on risk management approaches and consequences.

1.3 Bounding Conditions

The following key assumptions form the basis for project plans and the Performance Baseline for the project. Project contingency allowances are not intended to address or cover conditions that differ from this planning basis or events that occur in violation of these assumptions. In such cases a Baseline Change will be requested.

- Funding will be made available by DOE and the Congressional budget process in accordance with the profile which forms the basis for the baseline resource loaded schedule, as presented in the Project Execution Plan.
- There will be no changes to PPPL funding or programs that would have a major impact on the overhead rates upon which the baseline is based. In particular, the NSTX program will not terminate earlier than currently planned.

- There will be no extraordinary ESH incident or other event that causes an extended shutdown of the Laboratory or a stand down of laboratory activities.
- Certain risks with very significant potential consequences but a very low likelihood of occurrence are not covered by the contingency allowance for the project. Although these risks will be tracked and managed within the project, the project contingency allowances are not intended to cover the impacts of these risks if they are realized. The currently identified risks that fall in this category, and which are assumed will not occur for baseline planning purposes, are:
    - Major technical events requiring disassembly of the machine or a field period
    - Damage requiring refabrication of a coil (but damage requiring re-work in accessible areas, e.g. cooling tubes and leads, is covered.)
    - Damage requiring major disassembly and reassembly of a field period. (but disassembly / reassembly of individual joints during assembly is covered).
    - Failure of a key component or system during integrated system testing.
    - Large islands detected during e-beam mapping requiring extensive troubleshooting and remediation.
- CD-4 Project Completion criteria and requirements will not change from those described in the Project Execution Plan.

2 Responsibilities

While any member of the NCSX Project Team is expected to identify risks that become apparent, the responsibility for risk management for the NCSX Project rests with the NCSX line management.

Job Managers, WBS Managers, and Responsible Line Managers

Identify risks that can impact their work packages; assess the likelihood and potential cost and schedule impacts of the risk; identify and execute risk mitigation activities, and report on the status of both risks and mitigation activities.

Risk Owners

The person assigned by the Project to be responsible for reporting the status of the risk. Can be the job manager responsible for the mitigation effort, the job manager of the affected job, or a line manager. Can change with time.

Project Risk Manager

Has overall responsibility for managing project risks. The Project Integration Manager has been appointed as the Project Risk Manager

System Engineering Support Manager

Supports the implementation of the project's risk management program, e.g. by maintaining the risk registry.

3 Risk

3.1 Risk Definition

A risk is typically a negative outcome that, if it occurs, would adversely affect the project's ability to achieve overall project objectives within defined cost, schedule, and technical constraints. Risk can be categorized in two broad classes – Management and Organization Risks involving financial factors (e.g., funding profiles, escalation, labor an overhead rates, etc.) or loss of key personnel; and Technical Risks that have the potential to impact the performance of the machine (e.g., Assembly – both generic and specific, systems and components, startup, and systems). In the end, any risk has the potential to affect either or both costs and schedule and the NCSX Project has distilled all risks down to this basic accounting. In NCSX, the definition is broadened to include opportunities, i.e. positive outcomes that, if they occur, would improve the project's ability to achieve overall project objectives. Hereafter, we use "risk" to cover both negative and positive outcomes.

Terms associated with risk and its management are:

- Risk Management – the act or practice of dealing with risk. It involves assessments and planning for risk, implementing workable risk mitigation strategies and plans, monitoring risks to determine how they have changed, and updating risk documentation to assist in the overall project's ability to manage its risks.
- Risk Identification – the process of examining project areas and associated technical areas to identify and document risk items.
- Risk Analysis – the process of examining each identified risk item to refine the description of the risk, isolate the root causes of the risk item, and determine the effects and consequences should the risk item become a reality. It involves an assessment of each risk item in terms of the probability/likelihood of occurrence, severity of the consequence/impact in terms of cost and schedule, and any relationships to other risk items.
- Risk Mitigation – the process that describes the actions and/or plans to control an identified risk by risk reduction, contingency allowances, or elimination

3.2 Risk Mangement Processes

3.2.1 Risk Identification

Risk identification begins by compiling the project's risk items. Job managers identify potential risk items for their jobs at a level of detail that permits an evaluator to understand the significance of any risk, identify its causes, and estimate potential consequences.

3.2.2 .Risk Analysis

Risk analysis is a systematic evaluation of identified risk events by determining the probability of occurrence and consequences, assigning a risk rating based on established criteria, and prioritizing the risks. The first step in the risk analysis process is to determine for each risk event the probability that the risk item will actually occur. **Error! Reference source not found.** provides guidelines for classifying risks in terms of likelihood that they will occur.

Table 3-1 Likelihood of Risk Occurring

Risk Likelihood of Occurrence	
Classification	**Probability of Occurrence**
Very Likely (VL)	P≥ 80%
Likely (L)	80%< P ≥ 40%
Unlikely (U)	40% < P ≥ 10%
Very Unlikely (VU)	10% < P ≥ 1%
Not Credible (NC)	P < 1%

The next step in the risk analysis process is to determine for each risk item the magnitude of the consequences should the event occur. For the NCSX Project, consequences will be assessed in terms of cost and schedule impacts, and classified in accordance with **Error! Reference source not found.**.

Table 3-2 Risk Consequences

	Classification				
Impacts	**Negligible**	**Marginal**	**Significant**	**Critical**	**Crisis**
Technical	**No impact of performance**	**Minor degradation of performance**	**Moderate degradation of performance**	**Moderate degradation of performance**	**Desired performance in doubt**
Cost	**< $100K**	**≥$100K**	**≥$500K**	**≥$1M**	**≥$5M**
Schedule	**,<0.5 Months**	**≥0.5 Months**	**≥1 Months**	**≥3 Months**	**≥ 6 Months and will impact CD-4**

Once the risk likelihood and consequences are established, a risk ranking is assigned to each risk item. This rating is a qualitative measure of the severity of the risk item and provides a starting point for development of risk management priorities. The risk ranking is assessed based on likelihood and consequences, and classified as high, medium, or low in accordance with **Error! Reference source not found.**.

Table 3-3 Risk Ranking Matrix

		Impact				
		Negligible	Marginal	Significant	Critical	Crisis
Likelihood	VL	Low	Moderate	High	High	High
	L	Low	Moderate	Moderate	High	High
	U	Low	Low	Moderate	Moderate	High
	VU	Low	Low	Low	Moderate	High
	NC	Low	Low	Low	Low	Low

3.2.3 Risk Handling

There are four approaches to handling risk: avoidance, transfer, mitigation, and acceptance.

3.2.3.1 Risk Avoidance

A change in the concept, requirements, specifications, and/or practices that reduce risk to an acceptable level. Simply stated, it eliminates the sources of high or possibly moderate risk and replaces them with a lower risk solution and may be supported by a cost/benefit analysis.

3.2.3.2 Risk Transfer

Reallocation of the risk to other activities outside the NCSX MIE project, thereby reducing the overall project risk. In certain instances, risks may also be transferred to vendors through appropriate contract language and terms.

3.2.3.3 Risk Mitigation

Implementation of activities to reduce the consequences (likelihood and/or impact) of a risk event. The goal of mitigation is to retire risks so that their consequences do not affect the project or to minimize those consequences to the project. Mitigation activities are typically budgeted and scheduled in the project baseline unless those activities are on hold pending further project development or the occurrence of certain risk triggers.

3.2.3.4 Risk Acceptance

An acknowledgment of the existence of a particular risk situation and a conscious decision to accept the impact on the project's baseline. Acceptance can entail a decision not to mitigate a risk, or a decision to accept a residual risk after mitigation activities are completed. The impacts of an accepted risk must be budgeted and scheduled in the project baseline. Cost and schedule contingency allowances are included in the project baseline to cover the impacts of accepted risks.

3.3 Risk Documentation

The NCSX Risk Register is the vehicle for documenting identified risks, risk mitigation activities, affected jobs, ownership responsibilities, retirement deadlines, likelihood, consequences, estimated impacts and their bases, and the risk level classification. These items are tabulated in columns as follows:

- Affected Job - the job that will be impacted if the risk outcome occurs.
- Risk Description - the negative outcome (or in the case of an opportunity, the positive outcome), that might occur if not successfully mitigated.
- Mitigation Plan - budgeted tasks or activities to reduce the consequences. Identifies the Job number where the mitigation activity is budgeted in the project baseline. Note that the mitigation responsibility is often in a different job from the affected job.
- Deadline - sets a date (or event) when the risk will be retired. If not retired, then the consequences will be accepted and contingency drawn, if necessary, to cover it.
- Owner - i.e. the person assigned by the Project to be responsible for reporting the status of the risk. Can be the job manager responsible for the mitigation effort, the job manager of the affected job, or a line manager. Can change with time.
- Current Status: status of the risk and any mitigation activities. The owner is responsible for keeping this information up to date.
- Likelihood - probability that the risk will materialize, in bands (See **Error! Reference source not found.**).
- Consequences - categorization of impact, in bands (See **Error! Reference source not found.**).
- Risk Ranking - categorization dependent on likelihood and impact (See **Error! Reference source not found.**).
- Impacts - Cost Impact, Schedule Impact, and Basis of Estimate. Provides estimates in terms of dollars for cost impact and months for schedule (only maximum impact shown – minimum assumed to be zero). Indicator of the impacts/calls on cost or schedule contingency if the risk materializes. Basis estimate briefly describes what these impacts were based upon.

A sample page from the Risk Register is included as an attachment to the Risk Management Plan. The Risk Register can be found on the NCSX Engineering web page at:

http://ncsx.pppl.gov/NCSX_Engineering/Management/RiskRegister/NCSX_Risk_Register.pdf

3.4 The NCSX Project Risk Management Approach

The NCSX Risk Management approach consists of a three step process:

- The graded approach for managing risk;
- Identifying potential areas of risk;
- Active use and maintenance of the Risk Register

3.2.1 The Graded Approach for Managing Risk

Most NCSX activities related to the fabrication project require the preparation and completion of reviews, work planning, hazard analysis, and controls to properly manage the job. The first step in this process is to recognize the potential risk consequences and to assign ownership for the specific work. PPPL Engineering Procedure, *ENG-032, "Work Planning,"* provides the guidelines to be used to plan the anticipated requirements of a job; define the scope of the work; perform hazard analysis; provide for all environmental, safety, and health issues as part of the work planning and review process, establish procedural and testing requirements; and make other determinations, as necessary, to provide clear approvals indicating ownership of the work. Table 1 of *ENG-032* provides guidelines for applying the graded approach on how risk shall be managed with ascending levels of required approval based on three classifications of risk: standard, serious, and major category of risk as it pertains to mission and programmatic impact, ES&H, Cost, and Compliance factors. This procedure shall be followed whenever planning new or modifying existing work for NCSX.

3.2.2 Identifying, Mitigating, and Retiring Risk

The NCSX Risk Management process begins with the WBS Managers evaluating potential project risk for each work package. The process for identifying risk items is ongoing and is part of day-to-day interactions of the project team. Table 4-1,

Table 4-2, and Table 4-3 below provides a generic table of common risk areas to assist the WBS Managers in this task. Risk mitigation activities are planned to reduce (or in the case of an opportunity, increase) the likelihood or consequences of a risk, budget and scheduled in the project baseline, and executed and tracked as regular project work. The success criterion for risk mitigation activities is progress in reducing the risk and, ideally, retiring the risk altogether. A deadline is established by which the risk will be accepted if not retired. Acceptance means the residual consequences (cost and schedule impacts) are accepted and included in the project baseline.

3.4.1 Active Use and Maintenance of the Risk Register

The Risk Register is a living document with Job Managers continually updating/adding/retiring risks as they become known. Monthly the WAFs are statused as part of the NCSX Project Management System process and the status of existing Risk Register items and potentially any new items will be addresses as part of this statusing function. However, the job managers and risk owners are also responsible for reporting potential risk items more frequently in their day-to-day discussions with line management. As an ongoing process, the they will monitor performance relative to risk and evaluate the success of the risk mitigation strategies. WAFs and mitigation strategies will be adjusted as necessary to take advantage of lessons learned and to maximize the probability for successful project completion. .

4 Estimate Uncertainty

Each Job Manager is responsible for developing a detailed and thorough estimate of the resources (labor and materials and services) and time durations necessary to accomplish the assigned scope of work. Both cost estimates and schedule durations have inherent levels of uncertainty. In general, this uncertainty is a direct result of the degree of design maturity and complexity of the elements involved – in effect, how much definition exists to provide a basis for the estimate. This is a practical way of addressing the large and diverse number of potential uncertainties that often occur in acquisition projects.

As means to measure this uncertainty, the NCSX Project developed standard definitions for both design maturity complexity categorizations as shown in Table 4-1 and

Table 4-2.

Table 4-1 Design Maturity Definitions

Design Maturity	Definition
High	**Final design available. All design features/requirements are well known. No further significant design development or evolution is expected that will impact the estimate => relatively low probability of change..**
Medium	**Preliminary design is available. Some additional design evolution is likely. Further developments can be anticipate and will impact the estimate => relatively moderate probability of change..**
Low	**At the conceptual design level. Design details still need much development and evolution of requirements beyond the current estimate basis is anticipated and very likely => relatively high probability of change.**

Table 4-2 Design Complexity Definitions

Design Maturity	Definition
Low	**Work is fairly well understood – either standard construction or repetition of activities performed in the past. Little likelihood of estimate not being well understood and requirements not being well defined**
Medium	**More complex work requirements that have potential to impact cost and schedule estimates. Relatively limited experience performing similar tasks, so ability to estimate accurately is somewhat limited.**
High	**Extremely challenging tasks and/or requirements. Unique or first-of-a-kind assembly or work tasks. Very limited basis for estimating this work exists, so there is a high degree of uncertainty.**

Using accepted industry and DOE practices and guidelines, Table 4-3 below translates the combination of design maturity and design complexity into uncertainty ranges that are used in the contingency analysis.

Table 4-3 NCSX Estimate Uncertainty Ranges

		Design Complexity		
		Low	**Medium**	**High**
Design Matruiy	**Low**	**- 15% to +25%**	**-20% to +40%**	**-30% to +60%**
	Medium	**-10% to +15%**	**-15% to +25%**	**-20% to +40%**
	High	**-5% to +10%**	**-10% to +15%**	**-15% to +25%**

5 Contingency

The NCSX Project employs a structured process to assess and analyze all areas of risk and uncertainty that might affect the cost and schedule estimates on the projects. Probabilistic Risk Assessment Techniques (Monte Carlo Analysis) are used. The inputs to this analysis are the uncertainty ranges for each job and the likelihood and impacts for each risk. The result is an estimate of the cost and schedule contingency allowances required to cover the estimating uncertainties and risks in the project, and provide a given level of confidence that the proposed baseline estimates will not be exceeded. The details of this approach are covered in separate documentation.