National Compact Stellarator Experiment

NCSX

COST AND SCHEDULE ESTIMATING GUIDE

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RECORD OF REVISIONS

Revision	Date	Originator	Description of Change
0	5/27/2004	Simmons	Initial issue.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

NCSX National Compact Stellarator Experiment
Cost and Schedule Estimating Guide

1 Background

As part of the design evolution of the NCSX Project design and construction phases, the Project will be expected to present updated and more detailed technical, cost, and schedule estimates for consideration. The details provided in these estimates will provide the necessary detailed documentation to assure the DOE independent reviewers that the technical basis is sound and that the associated cost and schedule estimates are reasonable and well founded within the stage of the Project evolution.

NCSX estimates are generated for:

- The NCSX Fabrication Project defined by the Total Estimated Costs (TEC) – the TEC commences with start of Preliminary Design (Title I) and will end with the completion of First Plasma. For purposes of this estimate, the TEC activities commenced in April 2003. The NCSX technical, cost, and schedule baselines were established in February, 2004, with DOE approval of Critical Decision 2 (CD-2). The General Requirements Document (GRD) established the overall technical requirements for the Project and the lower level subsystem specifications, models, and drawings defined the specifics of the technical baseline. The cost baseline (TEC) consistent with the CD-2 technical baseline was $86.3M in year of expenditure dollars. The schedule baseline established at CD-2 which was consistent with the technical and cost baselines and the funding profile guidance provided by DOE led to a first plasma in May, 2008. As indicated in the NCSX Project Execution Plan (NCSX-PLAN-PEP) indicated that the TEC project will consist of :
    - Title I (Preliminary), Title II (Final), and Title III (Fabrication/Assembly Support) design, project engineering, and management and oversight;
    - Manufacturing Development (formerly called R&D – large scale prototype development);
    - Physics Analyses/Requirements Development in support of the design process (formerly called project physics); and
    - Equipment fabrication, assembly, installation, construction/fabrication management, and testing activities.

  Changes to the established CD-2 baseline are addressed and documented via the NCSX Configuration Control Program using Engineering Change Proposals (ECPs).

- Other Project Costs in Support of the NCSX Fabrication Project and/or NCSX Operations – as indicated above, costs incurred in support of the NCSX Fabrication Project and/or operations will be separately funded, but not counted

against the overall cost target of $86.3M. Per current DOE guidance, the following fall into this category:

- Research Prep activities being accomplished in parallel with the fabrication project will need to be separately funded, but are NOT in the TEC => this is primarily activities under WBS 91 and some physics activities under WBS 84 that are not in direct support of the project design and fabrication activities; and
- Operational spares (WBS 93) as appropriate.

2 Purpose, and Assumptions, and Formats

2.1 Purpose

The purpose of this document is to provide an overview of what is needed from you to develop the NCSX design cost and schedule estimate. The specific attachments provide detailed guidelines and standard formats to be used in developing and documenting this cost and schedule estimate. The goal is to produce a reliable cost and schedule estimate. *Whenever feasible, bottoms-up estimates should be utilized, using manufacturing and supplier input, catalogue information, and experience from similar projects.*

2.2 Assumptions

In order to develop a standard for developing the estimate, there are several basic assumptions that are defined:

2.2.1 Technical Basis of Estimate

The General Requirements Document (GRD) provides the overall top-level technical specification for the NCSX Project. The WBS Dictionaries are intended to provide an overview of the general work scope within each WBS. However, it is the associated lower-level specifications, models, and drawings that define the specific details of the technical baseline. All cost and schedule estimates developed shall be consistent with the latest applicable version of these lower-level specifications, models and drawings.

2.2.2 Standard Workweek

The standard workday is assumed to be 8 man-hours, usually between the hours of 8:00 am to 5:00 pm, with appropriate breaks for meals and relaxation. The standard workweek is assumed to be 40 hours, usually covering the period of Monday through Friday. Overtime premium for specific hourly workers will be applied for work outside the normal workday and workweek.

2.2.3 Units of Estimate

Estimates shall be provided in manhours (for laboratory labor) or in constant year dollars (materials and services and contingency), except where noted. The Project will notify personnel which constant year dollars the estimate shall be prepared in.

2.2.3.1 Labor

All laboratory labor estimates should be reported in **manhours** and **type of laboratory labor** (e.g., EAEM, EADM, EASM, EATB, ORNL Engineers/Designers, ORNL scientists, etc.). The NCSX Project Control team will put in fully loaded labor rates for PPPL and ORNL and will let the scheduling system (Primavera) price up the costs. Estimate of labor man-hour expenditures by year are needed to provide guidance for costing.

Estimates for near term work (e.g., within this fiscal year) should be provided in greater detail with specific names or skills needed.

For subcontracted labor services at PPPL, only the direct dollar estimates are required in constant year dollars => again Primavera will price up the fully loaded costs. For subcontracted labor services placed by ORNL, ORNL will supply the fully loaded constant year dollars to be input. Estimate of subcontracted labor services expenditures by year are needed to provide guidance for costing.

2.2.3.2 Material and Services (M&S)

Estimates for equipment and/or material contracts will be provided in constant year dollars. For the majority of major contracts, the NCSX Project will probably opt of a phased funding approach, so estimates should provide some guidance on how the phase funding might be spread over the contract. Estimate of equipment and material contract expenditures by year are needed to provide guidance for costing.

Estimates for withdrawals from the PPPL Stockroom will also be provided in constant year dollars. Estimate of PPPL Stockroom withdrawal expenditures by year are needed to provide guidance for costing.

2.2.3.3 Travel and Other Costs

Estimate of travel expenditures shall be provided in constant year dollars. The estimated travel expenditure by year is needed to facilitate proper costing.

Estimates of PPPL direct allocations shall be provided by the NCSX Project Control Manager following consultation with the PPPL Budget Office. Personnel will not be expected to provide estimates of direct allocation costs.

2.3 Standardized Formats

NCSX cost estimates shall be based on design information that satisfies the latest project requirements. You are asked to document the basis for your cost and schedule estimate (e.g., engineering judgment/scaling, vendor quotes if available, quantity takeoffs, unit pricing, etc.).

NCSX will be built on in the PBX/PLT Test Cell and with maximum use of existing PPPL and other fusion program equipment. In your estimating, please consider and identify the existing equipment and/or facilities that could be used by NCSX.

In order to ensure the information gathered and presented is consistent from WBS to WBS element, a set of "standardized" cost/schedule guidelines and forms have been developed for use by Work Breakdown Structure (WBS) Managers. These forms are a Word documents. The estimate will be prepared at the three digit WBS , with backup at a lower level developed. You can access the WBS and the necessary estimate forms and guidelines on NCSX Engineering web page:

< http://ncsx.pppl.gov/NCSX_Engineering/ >

There are several separate formats that should be utilized when developing your estimate; these are the Summary format and the Contingency Estimate format. By using standardized formats, documentation and review of the estimate details will be facilitated and will provide a consistent approach to understanding the estimates. The sections that follow will provide a brief description of the purpose of each format, some basic guidelines for completing the format, and a listing of key assumptions to be followed. The Attachments that then follow at the end of this procedure provide samples of these standardized formats. I should be noted that, as per Section 3.2 below, the estimate details can be provided in a format you desire, but the necessary information identified in Section 2.2.3 must be included.

2.4 Information Provided to You by the Project

The Project will provide specific funding and schedule guidance to you to kick-off the cost and schedule estimate effort. This may be provided as a Primavera output or another format such as Excel, etc. In addition, the NCSX Project Control Manager will provide you a timeline for developing your estimate, including submission of first draft, initial project review, iterations needed to finalize estimate, and submission of the final and complete estimate to fully document the cost and schedule estimate. The NCSX Project Control Manager and Systems Engineering Support Manager will be your primary points of contact if you have questions or need assistance in developing the necessary documentation.

The Project will also determine in what constant year dollars the estimate should be provided.

3 Cost and Schedule Estimate Formats

There are four basic standard formats to be used when developing your estimate. In addition to completing theset standard formats, backup documentation that supports the estimate must be provided. The backup documentation may be provided in a format (e.g., Word, Excel, PDF, PowerPoint, etc.) of your choosing. If at all possible, it is desired that all standard and backup formats be provided electronically.

3.1 Your Summary Format

This format summarizes your estimate scope, key assumptions made in developing the estimate, and any other pertinent guidance provided to you to facilitate the development of your estimate. This format (Attachment 1) is in a Word format. This format is divided into several sections:

3.1.1 General Description Section

This should be a brief (several paragraphs at the most) description of the overall scope of work to be performed, including description of major activities to be accomplished. This should correlate directly with the eventual 3 digit WBS dictionary found at:

< http://ncsx.pppl.gov/SystemsEngineering/WBS/WBS_index.htm >

As a starter, the basic WBS dictionary definition can be used for the "general description" section, but you should modify/expand as needed to ensure that the scope is clearly defined.

3.1.2 Key Estimate Assumptions

This section should clearly identify any key planning or scheduling assumptions (e.g., modular coils will be fabricated in series – all the C coils, all the A coils, and then all the B coils). This section, when coupled with the other information in this format, is critical to understanding the basis for the estimate.

3.1.3 Existing Equipment/Facilities to be Re-used

This section should clearly identify any major existing (either at PPPL or from other fusion laboratories) that you intend to re-use. For example, NCSX intends to re-use the much of the existing C-Site chilled water and electrical systems.

3.1.4 Major Modifications/Refurbishment Required to Existing Equipment/Facilities

This section identifies the major modifications/refurbishments that you believe are necessary to existing equipment and/or facilities. This includes not only modifications and refurbishment of existing equipment and/or facilities, but also any existing equipment and/or facilities that need to be removed to facilitate installation of your sub-system.

3.2 Your Estimate Backup Details

Your backup documentation can be submitted in a format of your choice, however, the necessary labor, subcontract labor, equipment and material subcontracts and travel estimates must be provided in the units described above in Section 2.2.3. It is critical that your laboratory labor estimates be provided not only in man-hours and type of labor (e.g., EAEM, EADM, EASM, EATB, ORNL Engineers/Designers, ORNL scientists, etc.), but also by expected year in which the labor will be expended. The same is true of the estimate details provided for subcontract labor services, equipment and material contracts, and travel.

As indicated earlier the cost estimate details requested have been organized to permit the Project to quickly allocate the costs to the proper cost category. For your part you need only concern yourself with estimating the following categories and subcategories (as appropriate). However, your estimate shall be submiteed as resorce-loaded tasks. Table 3-1below summarizes the detail and granularity of the estimate details needed.

Table 3-1 Estimate Details

Category	Unit of Estimate	Preliminary Design (Title I)	Final Design (Title II)	R&D	Fabrication & Support of Fabrication (Title III)	Testing& Commissioning
Lab Labor	**Man-hours**	**X**	**X**	**X**	**X**	**X**
Contracted Labor	**Constant Year Dollars**	**X**	**X**	**X**	**X**	**X**
Procured Equipment	**Constant Year Dollars**		**X**	**X**	**X**	
Procured Material	**Constant Year Dollars**		**X**	**X**	**X**	
Travel	**Constant Year Dollars**	**X**	**X**	**X**	**X**	**X**
Other Costs	**Constant Year Dollars**	**X**	**X**	**X**	**X**	**X**
Contingency Recommendation	**Percentage of Total Estimate**					

3.3 Contingency Estimate Format

This format (Attachment 2) is provided in Word format. Contingency is the amount of additional money, above and beyond the base cost, required to ensure the project's success from a cost perspective.

3.3.1 Contingency Estimating Process

The contingency estimate is developed by assessing risk and weighting factors in three areas; technical, schedule, and cost. Although the suggested processes for determining the appropriate percentage of contingency are outlined below, each WBS Manager has the option to modify it as appropriate to reach a more appropriate level of contingency for his sub-system. The processes procedure should be utilized as a starting point in determining your contingency:

3.3.1.1 Step 1 – Technical, Cost and Risk Factor Determination

Based on the experiences on several major fusion and high energy physics projects a menu driven approach to determining technical, cost, and risk factors has been developed by the Project. Table 3-2 below provides the standardized technical, cost and schedule risk factors to be utilized as a starting point in determining the appropriate contingency percentage.

Table 3-2 Technical, Cost, and Risk Factors

Risk Factor	*Technical*	*Cost*	*Schedule*
1	Existing Design and Off the Shelf H/W	Off the Shelf or Catalog Item	*Not Used*
2	Minor Modifications to an Existing design	Vendor Quote from Established Drawings	No Schedule Impact on Any Other Subsystem
3	Extensive Modification to an Existing Design	Vendor Quote with Some Sketches	*Not Used*
4	New Design, but Nothing Exotic	In-House Estimate Based on Previous Similar Experience	Delays Completion of Non-Critical Path Subsystem Activity
6	New Design, Different from Established Design or Existing Technology	In-House Estimate with Minimal Experience, but Related to Existing Capabilities	*Not Used*
8	New Design that Requires Some R&D, but Does Not Advance the State-of-the Art	In-House Estimate with Minimal Experience and In-House Capabilities	Delays Completion of Critical Subsystem Activity
10	New Design Development of New Technology which Advances the State-of-the Art	Top-down Estimate Based on Experience from Analogous Programs	*Not Used*
15	New Design, Way Beyond the Current State-of-the-Art	Engineering Judgment	*Not Used*

To start, you should select:

- An appropriate Technical Risk Factor based on the current state and level of the design;
- An appropriate Cost Risk Factor based on the overall estimating methodology used to arrive at the cost estimate for that subsystem; and
- an appropriate Schedule Risk Factor based on that subsystem's criticality to the overall schedule;

3.3.1.2 Step 2 – Weighting Factor Determination

The next step in the contingency estimating process is to compare the potential risk within a subsystem. Table 3-3 below provides the standardized technical, cost, and schedule weighting factors that have been developed for NCSX.

Table 3-3 Technical, Cost, and Schedule Weighting Factors

Area	Condition	Risk %
Technical	Design OR Manufacturing Uncertainties	2%
	Design AND Manufacturing Uncertainties	4%
Cost	Material Cost OR Labor Rate Uncertainties	1%
	Material Cost AND Labor Rate Uncertainties	2%
Schedule	For All Cases	1%

To start, you should select:

- An appropriate Technical Weight Factor based on the overall level of engineering and manufacturing difficulty for the subsystem. Often times it is not known if a certain design will be feasible or even whether it is but is simple to manufacture. Conversely, an item/subsystem may be engineered quite easily, but has never been built. Some items/subsystems may even be pushing the state-of-the-art with uncertainty in the producability of the design. Depending on the scenario between engineering and manufacturing, different Technical Weighting Factors may be applied.

- An appropriate Cost Weighting Factors based on whether that subsystem is primarily composed of assembly items, therefore having only possible labor rate impacts, or if material costs are also included meaning raw material prices, vendor estimates, and labor rates. The variability of these costs may affect the estimate, thus requiring a larger Cost Weighting Factor.

- For the NCSX Project, a **standardized** Schedule Weighting Factor of 1% has been assigned.

3.3.1.3 Step 3 – Determining Contingency Percentage

Once the Risk Factor and Weighting Factor is determined for each of the three areas (technical, schedule, and cost), multiply the individual risk factors by the appropriate weighting factors and then sum to determine the contingency percentage for each area. The final steps in the contingency determination process is sum the contingency percentages for

each area to arrive at a composite contingency percentage. The dollar amount of contingency will be determined by the NCSX Project Costing Team at PPPL by multiplying the base estimate by the calculated composite contingency percentage.to arrive at a contingency figure. The example below summarizes this final step:

- If the technical risk factor is 4 and the technical weighting factor is 4%, the total technical contingency component would be 4 x 4% = 16%.
- If the cost risk factor is 3 and the cost weighting factor is 2%, then the total cost contingency component would be 3 x 2% = 6%.
- If the schedule risk factor is 4 and the schedule weighting factor is 1% (Standardized), the total schedule contingency component would be 4 x 1% = 4%.
- The total calculated contingency would thus be 16% + 4% + 6% = 26%.

3.4 Schedule Estimate Format

In parallel with developing the cost estimate in the above categories, you will also be asked to develop schedule input the Project overall schedule guidance. Accordingly, major and interim milestones should be identified that will support the overall schedule guidance provided.

Once the estimate and schedule information is received, the Project will resource-load your schedules, using the appropriate labor and M&S information to develop the fully resource-loaded schedules. Primavera will be used as the Project scheduling tool. As a first cut, the Project will assume level loaded resources across the entire activity (e.g., preliminary design, etc.). Once the overall resource-loaded schedule is developed, the fiscal year costs will be compared to the available funding and adjustments made to either the individual schedules and resource-loading or both to arrive at resource-loaded schedules that are consistent with the available funding and project requirements.

Attachment 1 – Summary Format

WBS Number:	**Title:**
Originator:	
General Description of Work to be Performed: **Key Assumptions:** **Description of Existing Equipment/Facilities to be Reused:** **Description of Major Modifications Required to Existing Equipment/Facilities:**	

Attachment 2 – Contingency Estimate Format

WBS Level 4 Identifier:	**Title:**			
Originator:	**Date:**			
	Technical	**Cost**	**Schedule**	**Total**
Risk Factor (Table 3-2):				
Weighting Factor (Table 2-2):				
Percent				

Recommended Contingency Allowance (%):

Rationale for Selection of Contingency Allowance: