National Compact Stellarator Experiment

NCSX

PROJECT EXECUTION PLAN

(NCSX-PLAN-PEP)

Revision 0, Draft C1

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Revison 0, Draft A	8/23/01	Update by GHN & JAS
Revison 0, Draft B3	9/7/01	Revised draft to incorporate comments (Levine and GHN, et al comments thru Section 6)
Revison 0, Draft B3a	10/4/2001	Added Annex on contingency.
Revision 0 Draft B3b	10/15/01	Revised parts of WBS (Section 5), revised org chart to delete Executive Council
Revision 0 Draft B4	10/22/01	Updated to reflect definition TEC and revised cost profile
Revision 0 Draft B5	11/15/01	Revised definition of TEC and cost profile
Revision 0 Draft C1	12/12/01	Revised titles and number of annexes, revised Cost Objective (Sectdion 2.2.3), revised WBS to only 1 digit (Section 5)

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1.0 INTRODUCTION AND SCOPE OF THIS DOCUMENT

The National Compact Stellarator Experiment (NCSX) is an experimental research facility that is to be designed and constructed at the Department of Energy's Princeton Plasma Physics Laboratory (PPPL). Its purpose is to develop the physics of compact stellarators, an innovative fusion confinement concept. The facility will include the stellarator device and ancillary support systems. The design and construction project will be led by PPPL, in partnership with the Oak Ridge National Laboratory (ORNL).

This Project Execution Plan (PEP) covers the design and construction phase of the NCSX Project, including the integrated systems testing and producing the first plasma. The NCSX is a Major Item of Equipment (MIE) and therefore does not fall under the definition of a "project" in the strict DOE sense and definition. Nonetheless, the NCSX project management will, in a graded approach, follow the concepts outlined in DOE Order 413.3 and the implementing Project Management Guide and Best Practices Manual.

This PEP will be finalized immediately following the successful completion of the Conceptual Design Review when the appropriate lower level documents and plans will be in place. Where there are guiding PPPL documents (e.g., Project Control Systems Description and Integrated Safety Management Plan) and/or more detailed lower level documents (e.g., the Systems Engineering Management Plan (SEMP), Quality Assurance Plan (QAP), etc.), only a brief overview of the approach is included in this PEP.

2.0 MISSION NEED JUSTIFICATION/PROJECT OBJECTIVES

2.1 Mission Need

The National Compact Stellarator Experiment (NCSX) is needed to address one of the goals of the Department's Office of Fusion Energy Sciences program, namely to determine the attractiveness of the compact stellarator concept." It will address plasma physics questions that are critical to understanding magnetic confinement but which

cannot be addressed with existing facilities. The NCSX mission need (Critical Decision 0) was approved by the Office of Fusion Energy Sciences in May, 2001.

A program of experimental research will be carried out to accomplish this mission. The critical physics issues to be addressed– stability at high beta, confinement at high temperature, and divertor operation– set minimum plasma performance requirements. These considerations define the scale and scope of facility which is needed. They set the requirements on plasma size, magnetic field strength, plasma control, plasma heating, diagnostic access, and flexibility that the facility must satisfy. In the fusion program's concept development hierarchy, NCSX is in a class of facilities called proof-of-principle (PoP) experiments, of which the National Spherical Torus Experiment (NSTX) at PPPL is another example. The NCSX design and construction project addressed by this plan will provide an operational facility which meets the physics requirements necessary to support the NCSX physics mission. The mission itself will be carried out in the Operations phase.

2.2 Project Objectives

2.2.1 Technical Objective

The key technical objective of the NCSX project is the fabrication and assembly of an experimental facility capable of accomplishing the NCSX's physics mission. The facility will be capable of producing magnetized plasmas with a well defined set of configuration properties, namely size, shape, magnetic field strength, and pressure; these in turn determine its physics properties. Moreover, the NCSX will provide the flexibility to vary the plasma configuration over a range of flexibility. The plasmas to be studied are three-dimensional toroids, that is, doughnut-shaped plasmas whose cross sectional shape depends on where it is sliced. The magnetic field coils, which control the plasma shape, must be accurately constructed to precise shape specifications. The NCSX will provide heating, diagnostic, and power and particle handling systems sufficient for approximately the first year of experimental operation and will be able to accommodate later upgrades to these systems, depending on research needs.

The specific parameter objectives are as follows:

- Major radius R = 1.4 m;
- Toroidal field strength B_0 = 1.7 T for 0.2 second flattop in a reference plasma configuration;
- Neutral beam heating power P_{NB} = 3 MW

2.2.2 Schedule Objectives

The schedule objectives for the NCSX project are summarized in Table 2-1:

Table 2-1

NCSX Project Key Milestones

Milestone	**Schedule**
Physics Validation Review Completed	**March 2001A**
CD-0 Milestone Completed	**May 2001A**
Conceptual Design Review Completed	*April/May 2002 (??)*
CD-1 Milestone Completed	May 2002
Start Preliminary Design (Title I)	October 2002
CD-2 Milestone Completed	April 2003
CD-3 Milestone Completed	September 2003
Start Fabrication Activities:	October 2003
Procurement and Construction Completed:	November 2006
Start Pre-Ops Testing	November 2006
CD-4 Milestone Completed	December 2006
Start of Operation:	March 2007

2.2.3 Fabrication Project Cost Objective

The NCSX operational stage has been divided into several distinct research phases, however, for purposes of the NCSX Fabrication Project, only the four phases are relevant:

1. Initial Operation;
2. Field Line Mapping;
3. Initial Ohmic Heating; and
4. Initial Auxiliary Heating;

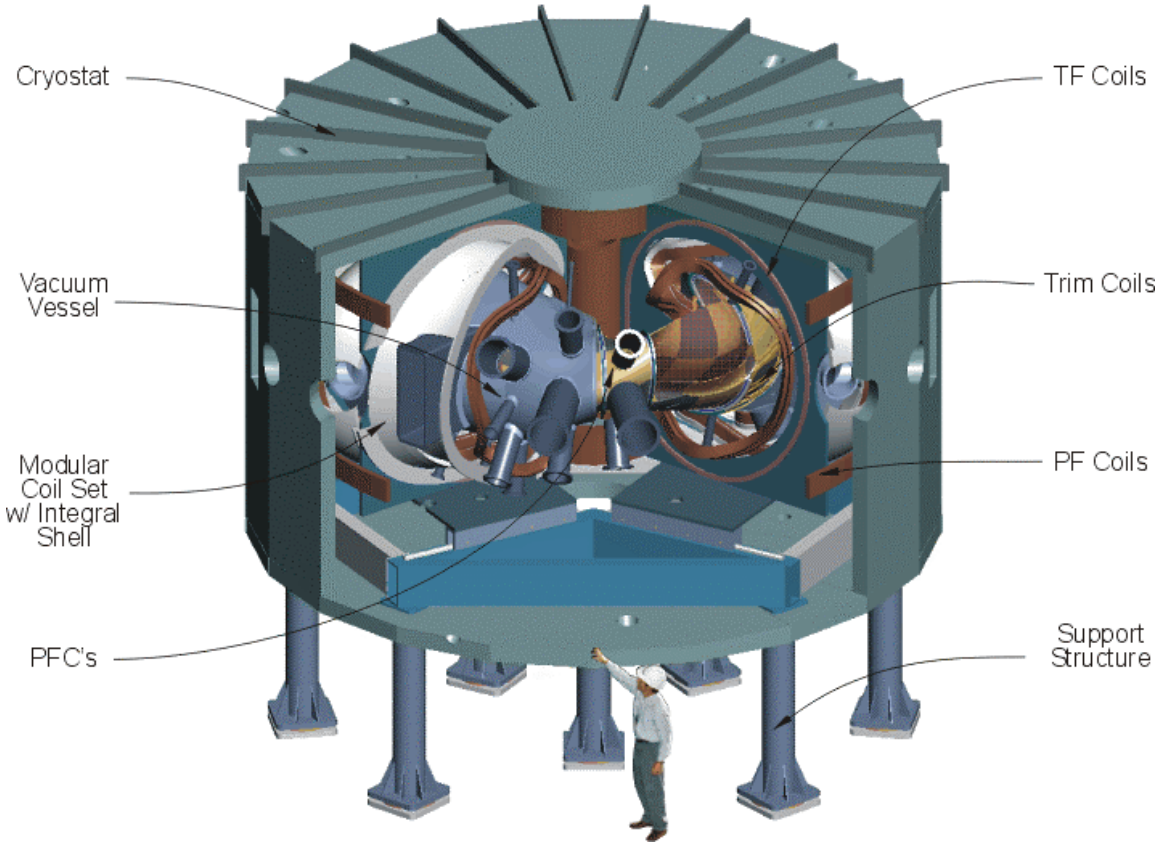
The NCSX Fabrication Project includes all the equipment required through the Initial Ohmic Heating phase of operation (i.e., Phases 1, 2, and 3), any modifications necessary to support testing of 3MW of neutral beams, and sufficient design work to ensure that all required upgrades to be added during phases 4 through 6 can be accommodated. Unless specifically excluded, all equipment in the Fabrication Project will be installed prior to first plasma (i.e., the start of Phase 1 – Initial Operation). The Fabrication Project cost objective is approximately $69M as-spent, assuming project execution in FY-2003 through 2007 and DOE escalation guidelines. This includes Title I through Title III engineering, physics requirements definition and analyses in support of this design, supporting manufacturing development, fabrication/assembly and installation activities, and commissioning and integrated systems tests.

In addition to the project cost objective, there are other activities in support research planning and preparation that will need to be funded annually, but separately from the Fabrication Project.

3.0 PROJECT DESCRIPTION

The NCSX project involves the design and construction of the NCSX facility. At the heart of the facility is the plasma confinement device, or stellarator core. This will be an assembly of several magnet systems that surround a highly shaped plasma. Coils provide the magnetic field for plasma shape control, inductive current drive, and field error correction. The vacuum vessel and plasma facing components produce a high vacuum plasma environment with access for heating, pumping, diagnostics, and maintenance. The entire system is surrounded by a cryostat to permit cooling of the magnets at liquid nitrogen temperature. Figure 3-1 shows a cutaway view of the stellarator core assembly.

Figure 3-1 NCSX Stellarator Core



The NCSX core will be assembled in the combined Princeton Beta Experiment/Princeton Large Torus (PBX/PLT) test cell at the Princeton Plasma Physics Laboratory (PPPL). It will be equipped with neutral-beam heating systems, pumps, fueling systems, diagnostics, control systems, and data acquisition systems. Site infrastructure such as cryogenic systems and utilility services will be included. The PBX/PLT computer and control rooms, which are contiguous to the test cell, will be refurbished and utilized. Power supplies located at D-site will be used.

The design of the stellarator core and facility re-configuration will be done by Laboratory (PPPL and ORNL) researchers and engineers. Development and manufacture of the major stellarator core components such as the coils and vacuum vessel will be done in industry, under contract to PPPL, or by a combination of industry and Laboratory efforts. The device will be assembled by Laboratory personnel. Ancillary systems will be assembled

from a combination of new and existing equipment. Major site credits to be used are the PBX-M neutral beams, D-site magnet power supplies originally used on TFTR, some C-site power supplies, the PBX-M vacuum pumping and gas injection systems, the test cell and associated infrastructure, and the adjacent control and computer rooms. As part of the project, the facilities and equipment to be re-used will be reconfigured or refurbished as needed to meet NCSX requirements. In the final stage of the project, an integrated testing program will be carried out and a plasma ("first plasma") will be produced in the device to make it ready for experimental operations.

4.0 MANAGEMENT STRUCTURE AND RESPONSIBILITIES

4.1 NCSX Project Organization Structure

The NCSX project will be led by the Princeton Plasma Physics Laboratory (PPPL) with the Oak Ridge National Laboratory (ORNL) providing major leadership and support as a partner. The partners have formed an integrated team to carry out the NCSX project, where engineers and scientists from PPPL and ORNL work together to bring the necessary expertise to the project. This means that PPPL engineers and scientists will support areas in which ORNL has the lead and similarly, ORNL engineers and scientists will support areas in which PPPL has the lead. Management responsibilities are clearly assigned to one partner or the other, and PPPL has overall responsibility for the project. Figure 4-1 depicts the NCSX project organization structure and the key management responsibilities of the partner institutions.

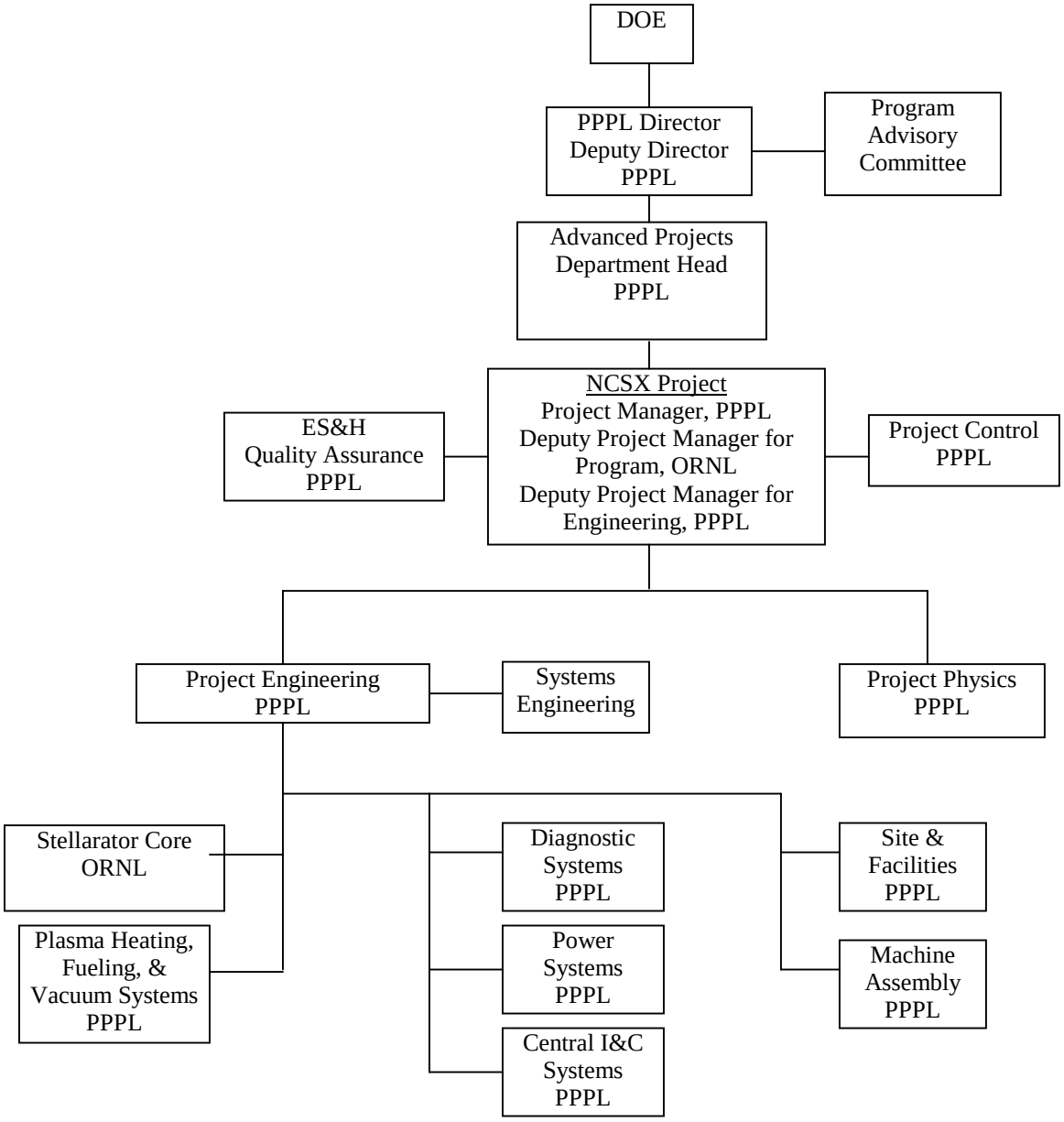


Figure 4-1 NCSX Project Organization Structure

The following subsections describe the relationships between the elements of the organization and their responsibilities.

4.1.1 U.S. Department of Energy (DOE)

Within the DOE, the responsibility for the NCSX Program resides in the Office of Fusion Energy Science (OFES) and an OFES NCSX Program Manager has been assigned. The

management responsibility, authority, and accountability for the day-to-day execution of the NCSX Project within the DOE are the responsibility of the Manager of the Chicago Operations Office (CH). CH has delegated major authorities and responsibilities for the NCSX Project to the Manager of the Princeton Group (PG), who has designated a DOE NCSX Project Manager.

4.1.2 DOE Contractor Organizations

4.1.2.1 Princeton Plasma Physics Laboratory (PPPL)

PPPL has overall responsibility for NCSX project execution, reporting to DOE through the Laboratory Director. The NCSX Project is assigned to PPPL's Advanced Projects Department. The Project Manager, the Deputy Project Manager for Engineering, the Engineering Manager, the Physics Head, and the Project Control Manager are PPPL positions. Project support in the areas of Quality Assurance and Environment, Safety and Health are provided by PPPL. Major procurements will be placed through PPPL's procurement organization.

4.1.2.2 Oak Ridge National Laboratory (ORNL)

ORNL is partner in the NCSX project with key management responsibilities. ORNL has management responsibility for the stellarator core (WBS 1). The position of Deputy Project Manager for Program is the senior NCSX project position at ORNL. Within the ORNL organizational structure, the NCSX Project is managed within the Fusion Energy Division. The Director of the ORNL Fusion Energy Division is a member of the NCSX Executive Committee (see Section 4.4).

4.1.2.3 Other Organizations

All other participants (i.e., industrial or university organizations) are subcontractors to either PPPL or ORNL.

4.2 NCSX Mangement Team

Key project positions and responsibilities are as follows:

4.2.1 Senior Laboratory Managers

4.2.1.1 PPPL Director

The PPPL Director has overall responsibility to DOE for the execution of the NCSX Project. He is supported by the Deputy Director.

4.2.1.2 PPPL Advanced Projects Department Head

The responsibility for NCSX is assigned to the PPPL Advanced Projects Department. The PPPL Advanced Projects Department Head reports to the PPPL Director.

4.2.2 NCSX Project Management Team

4.2.2.1 NCSX Project Manager

The NCSX Project Manager is responsible for execution of the NCSX project, including technical, cost, schedule, project control, ES&H, and quality assurance aspects. He is the project's primary point of contact with DOE and with the Program Advisory Committee. He reports to the PPPL Advanced Projects Department Head.

4.2.2.2 Deputy Project Manager for Program

The NCSX Deputy Project Manager for Program is an ORNL position. He supports the Project Manager especially on programmatic issues, and is the senior NCSX manager at ORNL. He reports to the Project Manager.

4.2.2.3 Deputy Project Manager for Engineering

The NCSX Deputy Project Manager for Engineering is a PPPL position. He supports the Project Manager, especially on engineering issues. He is the project's senior management representative in the PPPL engineering organization. He reports to the Project Manager.

4.2.2.4 NCSX Project Physics Head

The NCSX Project Physics Head is responsible for the physics requirements and supporting physics analyses as necessary. He reports to the Project Manager.

4.2.2.5 NCSX Project Engineering Manager

The NCSX Project Engineering Manager is responsible for carrying out the NCSX engineering design and construction to meet project requirements. He Reports to the Project Manager.

4.2.2.6 WBS Managers

The project engineering work organization is structured according to the work breakdown structure (WBS). Each WBS Level 2 element has a WBS Manager, who is responsible for the execution of the workscope. The WBS managers report to the Project Engineering Manager.

4.2.2.7 NCSX Project Control Manager

The Project Control Manager reports to the NCSX Project Manager and the Deputy Project Manager and is responsible for all project control and administrative functions necessary to support NCSX Project activities.

The NCSX Project Control Manager's support responsibilities include:

- Coordinating the development of project plans and administering the centralized Work Authorization system;
- Maintaining up-to-date NCSX cost and schedule baselines that are consistent with the technical baseline;

- Coordinating the preparation of statements of work, sole source justifications (as appropriate), the processing of requisitions, and tracking of procurements and subcontracts supporting the project;
- Establishing, maintaining, and monitoring project budgets and schedules to ensure consistency with project control milestones and funding;
- Operating the PPPL Project Control System (PCS) as the Project Control System for the NCSX Project.
- Assisting the Project Engineering Manager in administering the operation of the NCSX documentation, configuration management, requirements definition, and design description systems;
- Serving as the primary point-of-contact to the PPPL Business Operations Department; and
- Performing administrative functions such as space planning, facility maintenance coordination, travel approvals and vouchers, and overall personnel planning.

4.2.2.8 Quality Assurance and Environment, Safety & Health (ES&H)

A NCSX Quality Assurance Engineer and a NCSX Safety Engineer are assigned to support the NCSX Project Manager. A brief description of their responsibilities follows:

Quality Assurance Engineer support responsibilities - The NCSX QA/QC Engineer will assist the project in meeting quality assurance/control objectives. Support tasks include:

- Implementing PPPL QA policies and procedures applicable to the NCSX Project;
- Preparing a project QA plan;
- Providing quality related services such as calibration, inspection, testing, support of procurement activities, etc., related to QA; and

- Performing audits of compliance with, and assessments of performance of, NCSX plans and procedures.

Safety Engineer support responsibilities - The NCSX Safety Engineer will assist the project in meeting ES&H objectives. These include safe execution of the project and producing a facility that will be safe to operate. He will assist in implementing PPPL ES&H policies and procedures. The NCSX ES&H Engineer will prepare any required NEPA documentation and a Safety Assessment Document (SAD).

4.3 Program Advisory Committee

Advice by the U.S. and world fusion community on the NCSX Project scientific and technical issues is being obtained through the NCSX Program Advisory Committee (PAC). The NCSX PAC is comprised of a broad spectrum of technical experts of the U.S. and world fusion community. The PAC will provide this advice to the PPPL Director. It will address key technical issues identified by the NCSX Project Manager. It will meet periodically at the request of the PPPL Director.

5.0 WORK BREAKDOWN STRUCTURE (WBS)

The WBS organizes the NCSX project workscope and provides the logical structure that will be used to control the project. The WBS is composed of a few levels as required for work definition and control. By convention, the first digit in the WBS is designated "level 2," the second "level 3," etc. The Level 2 WBS matrix is provided in Table 5-1 below. This WBS is expanded and more completely defined in a series of separately issued and approved set of WBS dictionaries. The WBS Dictionary for each WBS element contains a brief description of the work scope for each element. For completeness, these WBS dictionaries contain elements not in the initial Fabrication Project, but considered for potential later upgrades during the operations phases.

NCSX Project Work Breakdown Structure

Table 5-1

WBS	Description (WBS Level 2)
1.0	**Stellarator Core Systems**
2.0	**Plasma Heating, Fueling, $ Vacuum Systems**
3.0	**Diagnostic Systems**
4.0	**Power Systems Modifications**
5.0	**Central I&C and Data Acquisition Systems**
6.0	**Site and Facilities**
7.0	**Machine Assembly**
8.0	**Project Oversight and Support**
9.0	**Preparations for Operations**

6.0 RESOURCE PLAN

6.1 NCSX Costs

As a Major Item of Equipment (MIE) the NCSX project will be funded primarily with Capital Equipment Funds. As a MIE project , the cost objective is measured by the Total Estimated Cost (TEC) – these cost encompass all the costs to design and construct NCSX, starting with Title I design and ending with completion of construction activities of the defined MIE project. In addition, manufacturing development activities and physics requirements and analyses in support of the design are included in the TEC. These TEC cost activities will be used to measure the performance of the NCSX Project against its technical, cost, and schedule baselines. Section 2.2.3 previously identified the cost target objective for this project.

Other project activities occurring in parallel with design and construction scope of the project that will support the MIE project include conceptual design activities, conceptual design R&D and manufacturing studies, and NCSX research preparation activities. These

will be funded with by Operating (OPEX) funds. These Other Project Costs (OPC) are not considered part of the overall cost objective outline in Section 2.2.3 of this PEP.

In accordance with DOE guidance, the historical costs for pre-conceptual and conceptual design of NCSX through FY-2002 were funded via OPEX funds and are not part of the TEC costs to design and construct NCSX.

6.2 Funding Profiles

Table 6-1 provides the NCSX funding profiles according to current project planning (October, 2001). It is assumed that Budget Outlay (BO) will equal Budget Authority (BA) each fiscal year.

Table 6-1

Preliminary NCSX Funding Profiles for the Project Execution Phase

	FY2003	FY2004	FY2005	FY2006	First Half of FY2007	Totals
	◄				►	
NCSX Construction Project	$11.1M	$16.0M	$17.0M	$17.0M	$7.9M	$69.0M
Research Preparations	$0.8M	$0.8M	$1.2M	$1.6M	$0.8M	$ 5.2M
TOTALS	**$11.9M**	**$16.8M**	**$18.2M**	**$18.6M**	**$8.7M**	**$74.2M**

7.0 PROJECT BASELINES

7.1 Technical, Cost, and Schedule Baselines

7.1.1 Overview

The NCSX Project technical, schedule, and cost baselines will be established in the conceptual design phase of the project They will be developed and validated as part of a Conceptual Design Review (CDR) or as a separate DOE Project Validation Review. Once these baselines are validated, the technical, cost, and schedule targets are established for Title I planning. However, in accordance with the DOE's baseline management policies, these baselines will not be finalized until the completion of the Title I (Preliminary) design is completed. At that time, they will come under the configuration control processes that are outlined later in this PEP.

7.1.2 Technical Baseline

The top-level technical document for the NCSX Project is the General Requirements Document (GRD). The GRD provides the top-level physics requirements that the design must satisfy. The details of the technical baseline will be documented in a set of drawings and supporting tables and dialog as necessary. Some of the drawings will be computer based CAD drawings. The drawings will include one or more assembly drawing for the overall device and one or more drawings for the individual subsystems. The number and level of drawings will be appropriate to the phase of the project. This package will form a primary element of the technical baseline and will evolve in detail through the phases of the project and through the change control process. A more detailed specification for this drawing package will developed in a NCSX procedure.

7.1.3 Cost and Schedule Baselines

The cost and schedule baselines are documented in the NCSX project resource-loaded schedule. The Primavera Project Planner (P3) commercial scheduling module will be the standard software used for the NCSX project. There will be a minimum of four levels of

detail starting with the Level I or Project Summary Schedule. This summary level schedule will identify significant DOE and project milestones and summary logic for the entire project. The other three levels of schedule are as follows and provide increasingly greater level of detail:

- Level II or Intermediate Schedules – will show major milestones and key tasks summarized by WBS, including key interrelationships.
- Level III or Job Level Schedules – are the detailed schedules prepared by the job manager. This schedule is established as part of the Work Authorization process and will span at least the current fiscal year. Since this schedule is the basis for each approved job or task, it is the heart of the cost and schedule baseline. These schedules will be resource loaded at the activity level and will form the basis for the NCSX Project Control System described in Section 10.0 of this PEP. Progress against established technical, cost, and schedule targets will be measured and evaluated monthly using the information contained in the Level III schedules.

  The activity detail that provides basis for these resource loaded schedules will be documented in a separate Cost and Schedule Document. These baselines will represent more refined versions of those presented at the time of the PVR and FY-2003 Project Validation. Specific contingencies will be presented and detailed resource-loaded schedules will be available. These schedules will clearly demonstrate the critical path activities, major milestones at both the summary and detailed levels. Level IV or Working Level Schedules – depending on the needs of the project, detailed working level schedules are prepared as needed. As critical tasks occur (e.g., complex hardware procurement, construction and installation tasks, etc.), activities that are covered in the Level III job schedules may be broken down into additional detail to allow for coordination of work by the responsible manager. Level IV schedules may also be developed by cognizant job managers to aid in the performance and control of their jobs. This level of schedule detail is normally not controlled at the same rigor as higher level schedules, but efforts are made to ensure continuity to established project milestones and Level III schedules.

8.0 Control of Project Baselines

8.1 Configuration Management Approach

Changes to the NCSX technical, cost, and schedule baselines will be controlled using a disciplined, yet flexible configuration management approach. This approach will ensure that the technical, cost, and schedule baselines are controlled at the appropriate level for the respective stages of the Project and that changes to the baseline will be carefully considered and evaluated for impact before proceeding

8.2 Change Control Process

The NCSX change control process ensures that changes to the NCSX design and requirements are properly identified, screened, evaluated, implemented, and documented. A formal procedure will be established prior to the beginning of Preliminary Design to implement the process of change classification and submittal of supporting documentation.

Once an Engineering Change Proposal (ECP) has been prepared and the impacts fully documented, the ECP will come before a project Change Review Board (CRB) that is comprised of senior members of the NCSX management team. The NCSX Project Manager will chair the CRB. Other members of the CRB will be assigned as appropriate, but may include the following:

- NCSX Project Control Manager
- NCSX Engineering Manager
- NCSX Physics Head (for proposed changes to the NCSX physics requirements)
- WBS Managers
- ES&H representative
- QA representative
- Other cognizant job managers impacted by the proposed change

The chairperson shall have the ultimate authority to recommend changes for the final approval; other board members act solely as advisors.

Once a proposed change is approved, the project will implement the change in a timely manner. An updated list of approved, disapproved, and pending changes will be maintained electronically on the NCSX File Share System.

8.3 Change Control Levels

Changes to the NCSX technical, cost, or schedule baselines will be classified according to their impact on the project. The change approval levels are established consistent with the technical, cost, and schedule risk and are intended to feed into the higher level DOE configuration change system. Table 8-1 summarizes the change classification and criteria.

Table 8-1

NCSX Change Classification Matrix

Category	Highest Level Approval	Criteria
A	DOE	• Changes to the established NCSX project cost target • Changes to DOE milestones • Changes requiring use of Contingency funds • Changes with significant ES&H impacts
B	NCSX Project Manager	• Significant changes to the GRD • Changes to the project baseline

9.0 Project Management and Control Systems

9.1 Project Management Systems Approach

The NCSX Project Manager will ensure that all project activities are properly controlled using PPPL's Project Control System (PCS). This system will be used as a management aid in planning and executing the project work scope and evaluation of schedule and budget performance. The status of progress and variance in the WBS elements will be reported monthly to the NCSX Project Manager.

The NCSX Project Manager will work to ensure early detection of technical, schedule or cost problems through routine project meetings with the NCSX project team. In addition to these routine meetings, periodic meetings attended by appropriate Project personnel will be held to report and discuss the Project overall status. Technical, cost, and schedule problems will be brought to the attention of the DOE Project Manager as soon as they are identified.

9.2 Project Control System Overview

The NCSX Project will use the existing PPPL Project Control System (PCS) as described in the PPPL Project Control System Description. This description describes the "graded approach" concept to be applied to PPPL projects and is available as a separate lab document. This document was reviewed and approved by DOE in 1996. The PPPL PCS satisfies the principles of project management and control systems outlined in this PEP and DOE Order 430.1 ("Life-cycle asset-management"). ORNL and other participants will utilize the PPPL PCS to ensure that the entire project cost and schedule performance is measured. The PCS provides a centralized work authorization system that the project will use.

The PCS is an integrated management control and reporting system that establishes the documentation, data requirements, information flow, and system disciplines necessary to operate and maintain a system for control of the NCSX Project work, costs, and schedules. The overall objective of the PCS is to provide PPPL and DOE with timely and

auditable cost and schedule performance information that can be used to monitor, control and manage Project progress. To accomplish this objective, the PCS provides a formal process for:

- Organizing the project work scope via the WBS;
- Planning and estimating the work scope via the project resource loaded schedule;
- Authorizing work and forecasting resource requirements via the WAF;
- Controlling management reserve and authorized allocated contingency via the change control process;
- Monitoring progress relative to schedule status and completion estimates and reporting cost and schedule performance against established cost and schedule baselines using the Level III schedules ;
- Documenting approved changes to the performance measurement technical, cost, and schedule baselines via the change control process; and
- Analyzing variances to the cost and schedule baselines, including critical path analyses resulting from statusing of the Level III schedules.

The key planning and measurement tool for the project is the Level III schedule, but the PPPL work authorization process forms the basis for development of these schedules. Through the work authorization process, details of work scope, schedule, budget, and responsibility will be integrated, documented, reviewed, and agreed to by both project management and the performing organization. The cognizant job manager will be responsible and accountable for accomplishing the scope of the work, as defined, with established schedule and cost targets. The vehicle for documenting and authorizing work is the Work Approval Form (WAF). The WAF formally documents the work scope to be performed, establishes a schedule, provides a cost estimate, identifies a responsible person for accomplishing the work, and provides time phased cost and manpower profiles.

9.3 Cost and Schedule Reviews

Nominally the Project will schedule two Cost and Schedule reviews with DOE each fiscal year. One review will be scheduled near the middle of the fiscal year during the period preceding the presentation of the Field Work Proposal and one near the end of the fiscal year. At these meetings the project will report the status of the project in general and the cost variances that potentially impact the level of contingency in particular. Information from progress in detailed planning will also be reported. Based on these inputs the project will recommend to DOE changes to the Project Baseline. This recommendation will be documented in the form of a formal change.

9.4 Reporting

Quarterly project reports will be prepared for the DOE NCSX Project Manager. However, to foster and facilitate visibility into project status all monthly PCS status will be provided to the DOE NCSX Project Manager. Additionally, DOE-PG participation in monthly meetings as well as design reviews will be encouraged.

10.0 Funds Management

10.1 Project Funding Mechanisms

PPPL and ORNL will each be funded directly via DOE B&R line. Participation of other organizations will be funded by either PPPL or ORNL through subcontracts. The annual NCSX funding requirements will be updated each year by PPPL and ORNL through their respective DOE Field Work Proposal (FWP) processes. Transfer of funds from PPPL to ORNL or vice versa will be accomplished by Financial Plan transfer requests to DOE. All project work and expenditure of project funds will be centrally authorized and controlled by the project office via the PCS.

10.2 Management Reserve Funds

Within the NCSX Project annual funding authorization, management reserve is a funding allowance for uncertainties or problems in the current year's work scope. At the beginning of each fiscal year, a separate management reserve account is funded by the NCSX Project Manager by not authorizing a small fraction of the work against the total

year's funding. Management reserve funds, whether held at PPPL or ORNL, are controlled by the NCSX Project Manager. As needs arise, the NCSX Project Manager will authorize disbursements of this management reserve to fund problem areas arising within the approved scope of work.

11.0 RISK MANAGEMENT

The NCSX project will use a tailored or "graded" approach to managing risk. Here, risk refers to factors within the project's control that threaten project performance, namely:

- Technical risk- the possibility that the product might not meet requirements
- Cost risk- the possibility that the cost might exceed the target value.
- Schedule risk- the possibility that the project might take longer to complete than planned.

Control of environment, safety, and health hazards, while part of risk management in a broader sense, is covered in other sections.

The project's risk management approach, as defined here, has two main components:

- Risk as a criterion in decision-making.- Simply put, risk reduction is a consideration in decision-making in all phases of the project. For example, when selecting among design options, potential vendors, or processes, the risks associated with the various choices will be assessed and factored into the decision.
- Management of contingency - A contingency allowance is established at the beginning of the project to provide for unanticipated scope changes and increases in in-scope costs. This contingency allowance is not included in the cost and schedule performance measurement baselines by which the project is measured and controlled, but is part of the approved cost baseline. It is a part of the project's budget whose purpose is to reduce risk. The amount of contingency is established initially based on a risk assessment performed as part of the cost estimating process process in preparation for the Conceptual Design Review. A formal risk-assessment methodology that considers technical, cost, and schedule risks at WBS Level 3 is applied, using a high-medium-low risk classification. The initial project contingency level is approved as part of the Project Validation Review. During

execution, contingency reductions are approved by the DOE NCSX Project Manager through the change control process. The Project Manager will maintain an up-to-date estimate of the remaining workscope and the cost to complete it, will assess the outstanding risks, and will strive to the keep the remaining contingency high enough to reduce the risks to an acceptable level. This will be a key feature of semi-annual project review meetings.

12.0 ACQUISITION STATEGY

12.1 Overview

The key feature of the NCSX acquisition strategy and planning is the procurement of the critical components that comprise the stellarator core. . The stellarator core includes the modular coils, vacuum vessel, supplementary coil systems (e.g., TF and PF), and plasma facing components (PFCs). The procured components will be assembled by Laboratory labor into the completed stellarator core assembly.

Although the design of the stellarator core systems will be led by ORNL, all major procurements for all systems will be placed by the PPPL Procurement Department.

12.2 Stellarator Core Systems Procurement

The Project has developed and is implementing the following acquisition strategy for the procurement of the NCSX stellarator core:

- **Conduct an information meeting at PPPL on the NCSX project and our procurement plans.** An information meeting was be held at PPPL in August, 2001, to explain NCSX and the scope and timing of our major procurements. The Project solicited expressions of interest in the major procurements at the information meeting.
- **Selected vendors to conduct manufacturing studies as part of the conceptual design**. Following the information meeting, the Project issued a Request for Proposal (RFP) for manufacturing studies of the vacuum vessel and modular coils. Site visits were conducted to assess contractor capabilities. These are fixed price contracts. The deliverables include recommended manufacturing processes, an

assessment of the feasibility and technical risks, recommended R&D activities to mitigate those risks, an estimate of the expected cost, and suggestions for alternate approaches.

- **Select one or more vendors to carry out the R&D required for the design and fabrication of the vacuum vessel and modular coils.** The project design activities, including the industrial manufacturing studies, will identify the R&D required for the vacuum vessel and magnets. Cost reimbursable contracts will be placed to carry out this R&D.
- **Select the vendors for the full-scale prototype** Cost reimbursable contracts will be placed with multiple vendors to construct full scale prototypes of a sector of the vacuum vessel and individual modular coils. These prototypes will confirm the fabrication process and provide cost and schedule information that will provide adequate control of the risk associated with the full fabrication contracts. The prototype construction will also provide input to fabrication vendor selection.
- **Select vendors for the production units**. The contract for the production units would be fixed-price. The contract for the vacuum vessel and modular coil production units would be open to bidding for all vendors who had satisfactorily completed the full-scale prototype. The fabrication of the TF and PF coils will also be through a fixed price contract. The PFC's, cryostat, and structure are not expected to offer significant challenges. The plan is to procure each of these under a fixed price contract.

Since the majority of the other systems will primarily be upgrades and/or modifications to existing PPPL systems and structures, it is anticipated that simple build-to-print of fixed price procurements based on firm specifications are feasible.

13.0 DOCUMENT CONTROL SYSTEM

13.1 Overeview

A Document Control System (DCS), adapted from existing PPPL document and drawing control systems using hard copy and electronic media, will be developed to ensure the organized and consistent treatment and format of NCSX documents including procedures,

plans, memos, drawings, calculations, requirements documents, design documents, and procurement documents. This DCS will utilize a standardized document numbering system and a World Wide Web (WWW) based file server (NCSX File Share) system to help ensure rapid review, authorization, updating, and retrieval of documents. Designated NCSX staff will maintain the NCSX File Share, with assistance from the PPPL Computer Systems Division. The URL for the NCSX Web page is http://www.pppl.gov/ncsx> and the NCSX File Share is located on that page.

A hierarchy of technical documents describes and specifies the NCSX facility. This approach can be depicted as a specification tree where the overall project-level specification is at the top and then is branched off to more detailed system, subsystem, and component specifications in a hierarchical fashion The major technical documents are:

- General Requirements Document (GRD). The top-level technical document for the NCSX Project, the GRD provides the top-level physics requirements that the design must satisfy.
- System Design Descriptions (SDDs) - These documents that (one each for the two digit or WBS level 3) describe the design and supporting analyses and R&D that to demonstrate that the design meets requirements. The detail (e.g., supporting analyses, R&D, etc.) contained in these implementing specifications will demonstrate that the design meets requirements and provide the basis for the majority of the design and construction activities, including development of cost and schedule estimates.
- Procurement specifications – These specifications provide the technical basis for subcontract solicitation and award. These specifications define the technical scope of work to be performed, the management systems and reporting requirements, and the miscellaneous documentation needed to support the procurement process.
- Design calculations – These documents provide the technical verification and integration of the design. These calculations will be controlled and maintained by the cognizant engineer and/or scientist.

- Design drawings and computer models – These CAD drawings provide the visible record and layout of the design. The computer-generated models provide the overall basis for design development and are used to integrate the engineering design and develop alternate configurations for consideration. As the primary design tool, these drawings and models will evolve as the design matures with increasingly more detailed information. These will be controlled on a separate restricted web site.
- NEPA Documentation - defines the impact that the NCSX project has on the environment.
- Safety Assessment Document (SAD) - documents the safety and health risks involved in NCSX and the systems and controls implemented to mitigate them; demonstrates how the NCSX Project design will meet ES&H requirements.

In addition to this the technical documents, there is also a series of management documents that serve to establish the framework for managing the NCSX. In addition to this PEP, the following management documents are key:

- Quality Assurance Plan (QAP) – defines how the existing PPPL Policies, Procedures, Plans and Documents will, in conjunction with additional NCSX procedures, as required, define systems that assure the quality of the NCSX project.
- Procurement Documents – includes statements of work and sole source justifications, as appropriate.

A document numbering scheme has been developed that provides the WBS (to the two digit or WBS level 3), the date in the format of YYMMDD, the abbreviated title of the document, the initials of the author, and the type of file extension (e.g., => .doc, .xls, .ppt, etc.). All participants are encouraged to use the project standards for documents of either the MAC or PC versions of Microsoft Word, Microsoft Excel, or Microsoft PowerPoint.

13.2 Document Review and Approval

The review and approval of the key NCSX documents, both original issue and revisions, will be in accordance with the key documents described in section 14.1 are provided below in Tables 13-1 and 13-2.

Table 13-1

Technical Document Approval Matrix[1]

	GRD	SDDs	PROC SPECS	Calcs	Dwgs	NEPA[2]	SAD
DOE CH Field Office Mgr.						A	
DOE OFES Director							
DOE OFES Program Mgr.							
DOE NCSX Project Mgr.			A				
PPPL Director							
PPPL Adv. Projects Dept. Head							A
NCSX Project Manager	A		A[3]			A	A
NCSX Project Physics Head	A						
NCSX Project Engineering Mgr.	A	A					A
NCSX WBS Managers				A	A		
NCSX QA Engineer							
NCSX ES&H Engineer							
PPPL ES&H Head							A
Change Review Board	X	X		X	X	X	X

Legend: A = Approve (Signature on Cover Page)

X = Revisions subject to configuration control procedures

Notes: [1]Revisions shall be subject to same review and approvals as the original

Document.

[2]Additional EA approvals within DOE are required but not listed here.

[3]Procurement documents such as Statement of Work and Sole Source Justification, as needed, will be approved at various project and DOE levels depending on dollar amount, procurement sensitivity, and procuring organization (i.e., PPPL or ORNL).

Table 13-2

Management Document Approval Matrix[1]

	PEP	QAP
DOE OFES Director		
DOE OFES NCSX Program Mgr.	A	
DOE NCSX Project Mgr.	A	
PPPL Director	A	
PPPL Adv. Projects Dept. Head	A	
NCSX Project Manager	A	A
NCSX Deputy Manager for Program	A	
NCSX Project Engineer Mgr.		A
NCSX WBS Managers		
NCSX QA Engineer		A
NCSX ES&H Engineer		
PPPL QA Mgr.		A

Legend: A = Approve (Signature on Cover Page)

Notes: [1]Revisions shall be subject to same review and approvals as the original Document.

13.3 Records Retention Plan

PPPL has developed an overall lab Records Management Plan (GEN-023) which lays out the categories and retention requirements for laboratory documents. Annex I to this PEP is intended to augment this Plan with specific NCSX Project guidance.

13.4 Project Completion Documentation

As required by DOE, a Project Completion Report will be prepared and submitted to DOE/PG within six months of completion of the Project. This report will provide the following information:

- The actual schedule on which the project will have been completed;
- The actual total project costs;
- The technical performance of the systems at project completion; and
- Itemized changes in cost, schedule, and technical parameters as compared to the initial baseline.

14.0 SYSTEMS ENGINEERING AND TECHNICAL MANAGEMENT

14.1 Systems Engineering

Systems engineering will manage the following activities:

14.1.1 Requirements

Systems engineering will manage the development and documentation of the project requirements. With the support of the review process systems engineering will assure that the design meets the project requirements.

14.1.2 Systems Integration

Systems integration will be responsible for configuration development and interface control. The configuration development activity will lead to the development of an Assembly Plan before the initiation of component assembly. Systems Integration will manage the assembly activity. An interface control procedure will be developed before the initiation of Preliminary design.

14.1.3 Technical Baseline Documentation and Control

Systems Engineering will be responsible for documenting and controlling the technical baseline. The technical baseline documentation approach will be specified in a procedure before the initiation of Preliminary Design. The control of the technical baseline will be via the Change Control process. Systems Engineering will manage the Change Control process.

14.1.4 Project Reviews

Systems engineering will manage the project review process. The NCSX Project will conduct a series of design reviews to assess the technical adequacy of the design as it is developed. In these reviews, the design is evaluated to verify conformance to the performance requirements and design constraints, demonstrate feasibility, define/update cost and schedule baselines, and identify necessary and/or additional R&D needed. Successful completion of these reviews is required prior to progressing to the next phase of design development. At a minimum, a series of three design reviews representing the progression of design are anticipated as follows:

Conceptual Design Review (CDR) – The CDR will assure that the General Requirements will provide a design that satisfies the project mission. It will assure the technical feasibility of the design and that the cost and schedule have been reasonable developed.

Preliminary Design Reviews (PRD's) – The PDR's are usually conducted on an individual subsystem basis or in groupings of related subsystems. One element of the scope of the PDR is to verify the subsystem requirements as allocated from the overall NCSX Project requirements and design constraints. These reviews assure that the subsystems designs satisfy the requirements and are sufficiently developed to begin Final Design.

Final Design Reviews (FDR's) – The FDR's assure that an adequate design has been developed to specify the components for fabrication and through the requirements this design will achieve the project mission.

14.1.5 Technical Assurance

By applying the PPPL technical assurance procedure Systems Engineering will assure that analysis is in place and adequately reviewed to support the design.

14.1.6 Value Engineering

Systems Engineering will manage a Value Engineering process specified in a Value Engineering procedure developed before the beginning of Preliminary Design.

14.1.7 Integrated Systems Testing

Systems Engineering will manage the Integrated Systems Testing activity which will include the development of an Integrated Systems Test Plan before the initiating of testing.

14.2 Quality Assurance

The NCSX Project QA Plan (QAP) will identify in a simple matrix fashion the major QA program elements. This QAP will conform to the PPPL Institutional Quality Assurance Plan (EQP-004). It will demonstrate how the existing PPPL QA Implementing Policies, and existing PPPL Implementing Procedures/Plans/Documents will, in conjunction with additional NCSX Procedures, provide conformance at a level appropriate for NCSX.

14.3 NEPA Documentation And Safety Assessment

NEPA Documentation [currently believed to be a request for a Categorical Exclusion (CX) determination] will be prepared for DOE-PAO approval prior to the CDR. The Safety Assessment Document (SAD) will be prepared and approved by PPPL prior to the start of operations.

15.0 INTEGRATED SAFETY MANAGEMENT PLAN

PPPL has prepared an Integrated Safety Management Plan (ISM) that has been approved by DOE. The NCSX Project intends to follow that ISM and to adopt this plan as its own for the conduct of the design, construction and operation of NCSX.

The Integrated Safety Management (ISM) at PPPL is comprised of:

- The governing policy that safety be integrated into work management and work practices at all levels.
- The distinct policies, programs, procedures, and cultural beliefs that PPPL has developed as the structure that PPPL workers utilize in fulfilling PPPL's environmental, safety, and health responsibilities.

The NCSX project will incoporate ISM into its management approach as follows:

- By accepting responsibility for safety as a line management responsibility. The project manager is responsible for safe execution of the project.
- By following PPPL procedures for work planning, where applicable. These procedures incorporate the ISM core functions of folding safety into the work planning, establishing appropriate controls, operating within established parameters, feedback. The "core functions" of ISM include the following 5 step process:
    - Defining the scope of work;
    - Analyzing the hazard;
    - Developing and implement hazard controls;
    - Perfoing the work within these controls; and
    - Providing feedback and continuous improvement to this process.

  Where project-specific procedures must be developed, ISM principles will be incorporated into them.

16.0 REVISIONS TO THE PROJECT EXECUTION PLAN

This plan, when adopted and approved following completion of the CDR, will remain in effect until the completion of the NCSX construction project. An annual review of the NCSX Project Execution Plan will be conducted, jointly by the PPPL Advanced Projects Department Head, the NCSX Project Manager, and the NCSX Engineering Manager to determine possible recommendations for update and/or revision. Revision and/or changes to this document will require approval of all the original signers of this document or their successors.