February, 2004

Critical Decision 2 Approve Performance Baseline for the National Compact Stellarator Experiment Project At Princeton Plasma Physics Laboratory

Office of Fusion Energy Sciences, Office of Science

A. Purpose:

The purpose of this paper is to document the review by the Office of Science Energy Systems Acquisition Advisory Board-equivalent (ESAAB) for the Critical Decision 2 (CD-2) "Approve Performance Baseline" for the National Compact Stellarator Experiment (NCSX) Project at Princeton Plasma Physics Laboratory (PPPL).

In May, 2001, the Acquisition Executive, Dr. N. Anne Davies, Associate Director of the Office of Fusion Energy Sciences (OFES), approved the "NCSX Mission Need Statement" as Critical Decision 0 (CD-0). The DOE identified a preliminary funding range of $69M +20% for the NCSX Project in its FY 2003 budget request to Congress.

In November, 2002, Dr. Davies approved the Preliminary Baseline Range (CD-1) for the NCSX Project at PPPL. The DOE also identified a preliminary funding range of $69M +20% for the NCSX Project in its FY 2004 budget request to Congress.

B. Introduction to the NCSX Project:

The NCSX and the stellarator proof-of-principle program were proposed to DOE in May, 1998. A peer review panel and later the Fusion Energy Sciences Advisory Committee (FESAC) recommended development of the physics basis and pre-conceptual design for NCSX, which was done over the next few years. As the pre-conceptual design evolved, several implementation approaches for the core device were considered, ranging from a modest reconfiguration of the existing Princeton Beta Experiment - Modification (PBX- M) device to all-new fabrication. Trade studies examining a range of plasma configurations and coil topologies were conducted to support the decision process. Based on trade study results, PPPL selected fabricating a new device as the best approach. The main design features were established in a series of decisions in late 2000 and early 2001: the reference plasma configuration and its associated physics properties, modular coils for the main helical field magnets, and the size and performance parameters. The results of trade studies and alternative configurations support the conclusion that the best design approach for the mission was chosen. A second peer review, a Physics Validation Review in March 2001, confirmed the soundness of the NCSX physics design basis and the appropriateness of the implementation approach based on the pre-conceptual design. On that basis, the compact stellarator was endorsed as a proof -of -principle concept by the FESAC, and the mission need CD-0 was approved by the DOE, Office of Fusion Energy Sciences (OFES) in

May 2001. Following CD-0, minor adjustments were made to the scope, cost and schedule reflecting results of the conceptual design process and review, recent industrial manufacturing development studies, and programmatic adjustments in the funding profile.

Following CD-0 approval, the project began Conceptual Design activities, conducted a Conceptual Design Review, and achieved the CD-1 milestone in November, 2002. The lengthy Continuing Resolution in FY2003 delayed this “new start” project, and Title 1 design did not commence until April, 2003. Three major reviews, all of which are pre-requisites to CD-2, were recently completed. These include the Preliminary Design Review, a performance baseline review conducted by Office of Science Construction Management and Support Division, and an External Independent Review, conducted by Office of Engineering and Construction Management (OECM). All three of these review committees enthusiastically endorsed the project as being ready for CD-2. The scope, schedule, & cost baselines proposed at this time reflect the project’s accumulated technical knowledge to date as well as the recommendations of all review committees. The most significant recommendation involved the re-definition of project completion (CD-4). The Integrated Project Team is confident that the project can be successfully completed within the established parameters. The implementation of the comments received from all project reviews and recently imposed budget/funding limitations have resulted in an increase in project Total Estimated Cost (TEC) to the current $86.3M.

C. Mission Need and Justification:

Fusion is the power source of the sun and the stars. The sun and stars are comprised of a special state of matter called "plasma." In this plasma, hydrogen nuclei combine, or "fuse," to form nuclei of a heavier element, helium. In the process of fusing, some of the mass involved is converted directly into large amounts of energy. Fusion researchers seek to harness this energy for applications such as central station electrical generation. The mission of the U.S. Fusion Energy Sciences Program is to "advance plasma science, fusion science, and fusion technology -the knowledge base needed for an economically and environmentally attractive fusion energy source."

NCSX is an integral part of the Department's Office of Fusion Energy Sciences program and provides a unique opportunity to advance its mission. The mission of the NCSX is to acquire the physics knowledge needed to evaluate compact stellarators as a fusion concept, and to advance the physics understanding of three-dimensional plasmas for fusion and basic science. This mission of the NCSX supports two of the Fusion Energy Sciences program's goals (Report of the Integrated Program Planning Activity, December, 2000), namely:

1. Resolve outstanding scientific issues and establish reduced-cost paths to more attractive fusion energy systems by investigating a broad range of innovative magnetic confinement configurations.

2. Advance understanding of plasma, the fourth state of matter, and enhance predictive capabilities through comparison of well-diagnosed experiments, theory, and simulation.

D. Preliminary Design Report:

A Preliminary Design Report (PDR) is required for CD-2 approval. A PDR was prepared for review in FY2003, and a successful review was conducted in October, 2003. The Review Committee report and recommendations were received by the Integrated Project Team in late October, 2003. A disposition report which addresses all of the recommendations of the committee is available, and the Integrated Project Team (IPT) reviews it regularly.

E. Project Execution Plan:

A Project Execution Plan (PEP) is a prerequisite for the CD-2 approval. The document has been finalized and approved.

F. Project Scope Baseline:

The scope of the NCSX Project consists of the design, fabrication, assembly, and initial startup of the NCSX device. The PEP contains a more detailed technical scope definition and description of the project. Successful completion of project scope is defined by production of a "first plasma" with coils at cryogenic temperatures as defined in the PEP. The recommendations of all review committees have been factored in to the current project baseline scope.

G. Project Cost and Schedule Baseline & Resource Loaded Schedule:

The NCSX Project is classified as a Major Item of Equipment (MIE) and is funded with Capital Equipment funds. For such an MIE, the TEC of the NCSX Project is considered to be equivalent to the Total Project Cost (TPC). The current TEC funding plan is shown in the table below:

TEC - Fiscal Year Resource Plan

FY	2003	2004	2005	2006	2007	2008	TOTAL
	$7.9M	$15.9M	$15.9M	$22.1M	$19.4M	$5.1M	$86.3M

The TEC, broken down by Work Breakdown Structure (WBS) categories, is shown in the table below:

WBS Item #		
1	Stellarator Core	$42.3M
2	Auxiliary Systems	$ 1.6M
3	Diagnostic Systems `	$ 1.7M
4	Electrical Power Systems	$ 5.3M
5	Central I & C Systems	$ 2.6M
6	Facility Systems	$ 2.0M
7	Test Cell Prep & Machine Assembly	$ 4.3M
8	Project Management & Integration	$10.6M
Total costs		$70.4M
Contingency		$15.9M
Total Estimated Cost		$86.3M

The proposed top level schedule baseline is as follows:

CD-0 Approve Mission Need	May, 2001
CD-1 Approve Preliminary Baseline Range	November, 2002
CD-2 Approve Performance Baseline	February, 2004
CD-3 Approve Start of Construction (i.e. Fabrication)	October, 2004
CD-4 Approve Transition to Operations	May, 2008

H. Acquisition Execution Plan:

An Acquisition Execution Plan (AEP) is required for CD-2 approval. The document has been finalized, reviewed by OECM as required, concurred in by OFES, and approved by the Under Secretary of Energy, Science and Environment. The acquisition strategy in this document is still valid, and therefore revision to the AEP will not be made at this time. Changes in scope, schedule, and cost baselines that have occurred since the AEP was approved are captured in the current version of the PEP.

The NCSX will be designed and fabricated at PPPL, which will have lead responsibility for execution of the NCSX Project. The Oak Ridge National Laboratory (ORNL), as a partner to PPPL**,** will provide major support, including leadership in specific areas. Combining the PPPL and ORNL team is advantageous as both laboratories have extensive experience in the design and fabrication of stellarators and other fusion confinement experiments.

While the NCSX Project consists of an integrated team of both PPPL and ORNL personnel, imposing a single point of contact for major procurements offers significant advantages. Assigning the major procurements to PPPL will streamline the procurement process by utilizing

the same procurement personnel to conduct all procurements regardless of whether designed by PPPL or ORNL.

Commercial and best business practices will be used to accomplish all procurements. Many of the equipment procurements will use commercial or best value source selection concepts allowing cost and technical trade-offs to ensure the best value is obtained in acquiring components. Fixed price contracts are contemplated for all production procurements. As part of the phased acquisition strategy, early involvement of industry in developing viable manufacturing solutions should facilitate the use of fixed price contracts for the production phase. In addition, consideration will be given to a wide dissemination of draft solicitations prior to formal solicitation as well as the use of pre-proposal and pre-award conferences.

The NCSX Project has committed to a high degree of supplier input and participation in the development of requirements for major systems, while at the same time maintaining appropriate in-house control and responsibility for definition, design and integration of these items. The Project will continue to encourage supplier participation through publication of preliminary design information on its public web site. To date, the Project's efforts to identify interested industrial suppliers has generated a list of more than 20 firms from the United States, Europe and Japan that are now actively participating in NCSX manufacturing studies or tracking the Project with the object of participation in its later phases.

The majority of the subcontracted work to be performed for NCSX consists of hardware fabrication. The major stellarator core components to be specially fabricated for NCSX will be the subject of a multi-stage development program that will yield designs that permit fabrication under fixed-price "build-to-print" subcontracts. Depending on schedule considerations, it may be appropriate to use one or more fixed-price incentive subcontracts, with negotiated targets based on delivery or cost. These performance based subcontractor incentives will be considered by the Project if such incentives appear necessary or appear to offer appropriate cost, schedule, or technical advantages to the Project. For the ancillary systems components, it is anticipated that the majority are readily available off-the-shelf.

The Project will attempt to promote and maintain the cost-reduction effects of competition throughout all phases of acquisition, including the acquisition of major components. As described above, the designs of those components that pose the highest degree of manufacturing risk will be developed through a series of manufacturing studies, a prototype fabrication and finally, a production fabrication subcontract. At each step, to the maximum degree possible, information will be made available to all interested suppliers, and the submission of competitive proposals will be encouraged. Off-the-shelf hardware will be purchased through the PPPL procurement system, using a variety of appropriate, competitively-awarded purchasing vehicles, including subcontracts, purchase orders and blanket purchase agreements.

I. Environmental Strategy:

In compliance with the National Environmental Policy Act (NEPA), the Chicago Operations Office (CH) has performed a NEPA Guidance Review. The results of the review are that: the environmental hazards associated with the NCSX Project appear to be well within range of those currently existing for similar fusion experiments at PPPL. Consequently, a Finding of No Significant Impact (FONSI) was signed in December, 2002.

J. Integrated Safety Management & Preliminary Hazard Analysis Report:

A preliminary Hazard Analysis Report is a prerequisite for the CD-2 approval and has been prepared. The NCSX Project's Environmental Evaluation Notification Form (EENF) report documents the safety analysis of the NCSX Project design and operation. The report's purpose is to identify hazards associated with the design and operation of the NCSX Project; assess risk; and establish controls needed to eliminate or reduce the associated risk to acceptable levels. Specific ES&H hazards and the means for their mitigation have been detailed, and will be managed through the PPPL Integrated Safety Management (ISM) Program.

K. Project Controls & Earned Value Management System:

An Independent Review of the NCSX Project Control System was conducted in February, 2003. The review committee found that the system was in full conformance with accepted industry standards.

L. CD2 Pre-requisites:

The following information is available at http://ncsx.pppl.gov//Meetings/PDR/CD2.html for ESAAB committee review:

Project Execution Plan
Acquisition Execution Plan
Integrated Project Team & Charter
Resource Loaded Schedule
Detailed Project Cost and Schedule Estimates
NEPA Documentation
Risk Analysis & Risk Management Plan
System Functions and Requirements (GRD)
Hazards Analysis & ISM planning documentation
Value Management/Engineering
Project Controls/Earned Value Management System
Preliminary Design Review & Review Committee report*
External Independent Review & Review Committee report*
Performance Baseline Review & Review Committee report*

*includes IPT Corrective Action Plans for all recommendations

February, 2004

NATIONAL COMPACT STELLARATOR EXPERIMENT (NCSX) PROJECT

CD-2 REQUEST

Submitted by:

_____ Date:_____
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_____ Date: _____
Jerry Wm. Faul
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_____ Date: _____
Gene R. Nardella
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February, 2004

NATIONAL COMPACT STELLARATOR EXPERIMENT (NCSX) PROJECT

CD-2 REQUEST

Recommendations:

The undersigned "Do Recommend" (Yes) or "Do Not Recommend" (No) approval of CD-2, Approve Performance Baseline for the National Compact Stellarator Experiment Project at PPPL as noted below:

_____ Yes ___ No ___
ESAAB Secretariat, Construction Management and
Support Division/Date

_____ Yes ___ No ___
Representative, Non-Proponent SC Program Office/Date

_____ Yes ___ No ___
Representative, Environmental Safety and Health Division/Date

_____ Yes ___ No ___
Representative, Financial Management Division/Date

_____ Yes ___ No ___
Representative, Security Management Team/Date

_____ Yes___ No___
Representative, Office of Engineering & Construction Mgmt/Date

_____ Yes ___ No ___
Representative, Grants & Contracts Division/Date

_____ Yes ___ No ___
Representative, Laboratory Infrastructure Division/Date

Approval:

Based on the material presented above and this review, Critical Decision 2, Approve Performance Baseline, is approved. Therefore, the Princeton Area Office is authorized to continue with expenditure of Major Item of Equipment funds for the National Compact Stellarator Experiment Project.

_____ _____
Dr. N. Anne Davies DATE
Associate Director
Office of Fusion Energy Sciences