

**Approval of Preliminary Baseline Ranges (CD-1)  
for the  
National Compact Stellarator Experiment (NCSX) 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 for the critical decision “Approval of Preliminary Baseline Range (CD-1)” for the National Compact Stellarator Experiment (NCSX) Project at Princeton Plasma Physics Laboratory.

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.

**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 of 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. 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 Critical Decision 0 (CD-0) was approved by the DOE, Office of Fusion Energy Sciences (OFES) in May 2001. Since the time of the CD-0, minor adjustments have been 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. These adjustments have been accomplished well within the cost range identified in the FY2003 budget request to Congress.

The NCSX will be designed and fabricated at the Department of Energy's Princeton Plasma Physics Laboratory (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.

### **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."

The National Compact Stellarator Experiment (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:

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

### **D. Conceptual Design Report**

A Conceptual Design Report (CDR) is required for CD-1 approval. A Conceptual Design Report was prepared for review in May, 2002, and a successful review was conducted at that time. The Review Committee report and recommendations were received by the Integrated Project Team in June, 2002.

**E. Project Execution Plan**

A preliminary Project Execution Plan (PEP) is a prerequisite for the CD-1 approval. The document has been finalized and approved.

**F. Project Preliminary Scope Baseline**

The scope of the NCSX Project consists of the design, fabrication, assembly, and initial startup of the NCSX device. Successful completion of project scope is defined by production of a “first plasma” as defined in the Project Execution Plan.

**G. Project Preliminary Cost and Schedule Baseline**

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

<u>Preliminary TEC Funding - Resource Plan</u>	
<b>Fiscal Year</b>	<b>(\$K)</b>
2003	\$ 11,000
2004	\$ 16,000
2005	\$ 20,500
2006	\$ 17,800
2007	\$ 8,200
2008	\$ 0
<b>Total:</b>	<b>\$73,500</b>

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

NCSX Project Preliminary TEC by WBS

<b>WBS Item #</b>	<b>Task Description</b>	<b>Total Budgeted Cost in then- year funds (\$M)</b>
1	Stellarator Core	\$30.2
2	Heating, Fueling, Vacuum Systems	\$ 2.3
3	Diagnostics	\$ 2.5
4	Power Systems	\$ 5.6
5	Central I & C	\$ 4.1
6	Facilities	\$ 1.8
7	Machine Assembly	\$ 3.4
8	Integration & Management	\$ 7.3
	Total costs	\$57.2
	Contingency	\$16.3
	<b>Total Estimated Cost</b>	<b>\$73.5</b>

The preliminary top level schedule baseline is as follows:

CD-0	Approve Mission Need	May, 2001
CD-1	Approve Preliminary Baseline Range	Aug, 2002
CD-2	Approve Performance Baseline	Jun, 2003
CD-3	Approve Start of Construction (i.e. Fabrication)	Nov, 2003
CD-4	Approve Transition to Operations	Jun, 2007

## **H. Acquisition Execution Plan**

An Acquisition Execution Plan is required for CD-1 approval. The document has been finalized, reviewed by OECM as required, concurred in by OFES, and is currently in the signature process.

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 Protection 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. Thus, a Finding of No Significant Impact (FONSI) will be requested and is expected to be reached by February, 2003..

**J. Preliminary Hazard Analysis Report**

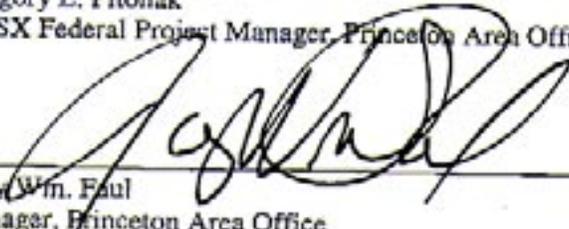
A preliminary Hazard Analysis Report is a prerequisite for the CD-1 approval and has been prepared. The NCSX Project's Environmental Evaluation Notification Form (EENF) report documents the safety analysis of the NCSX Project design and operation. The report's purpose is to identify hazards associated 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.

**National Compact Stellarator Experiment (NCSX) Project  
CD-1 Review**

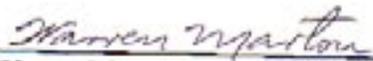
Submitted by:

  
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Gregory E. Pitonak  
NCSX Federal Project Manager, Princeton Area Office

Date: 8/1/02

  
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Jerry Wm. Faul  
Manager, Princeton Area Office

Date: 8/2/02

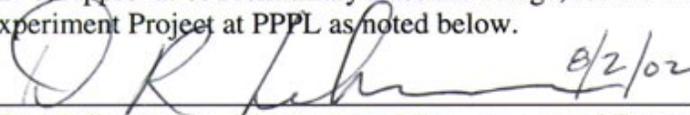
  
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Warren Marton  
NCSX Program Manager, Office of Fusion Energy Sciences

Date: 8/2/02

**National Compact Stellarator Experiment (NCSX) Project  
CD-1 Review**

**Recommendations**

The undersigned "Do Recommend" (Yes) or "Do Not Recommend" (No) approval of CD-1, Approval of Preliminary Baseline Range, for the National Compact Stellarator Experiment Project at PPPL as noted below.

 8/2/02 Yes  No

ESAAB Secretariat, Construction Management and Support Division/ Date

Michael F. Teresinski Yes  No

Representative, Non-Proponent SC Program Office/ Date

Barry S Park Yes  No

Representative, Environmental Safety and Health Division/ Date

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Yes  No

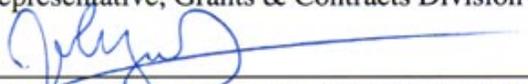
Representative, Financial Management Division / Date

Wm D. Long 8/2/02 Yes  No

Representative, Security Management Team / 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 1, Approval of Preliminary Baseline Range, is approved. Therefore, the Chicago Operations Office is authorized to proceed with expenditure of Major Item of Equipment funds for the National Compact Stellarator Experiment Project.



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

NOV 18 2002

Date