Department of Energy
Review Committee

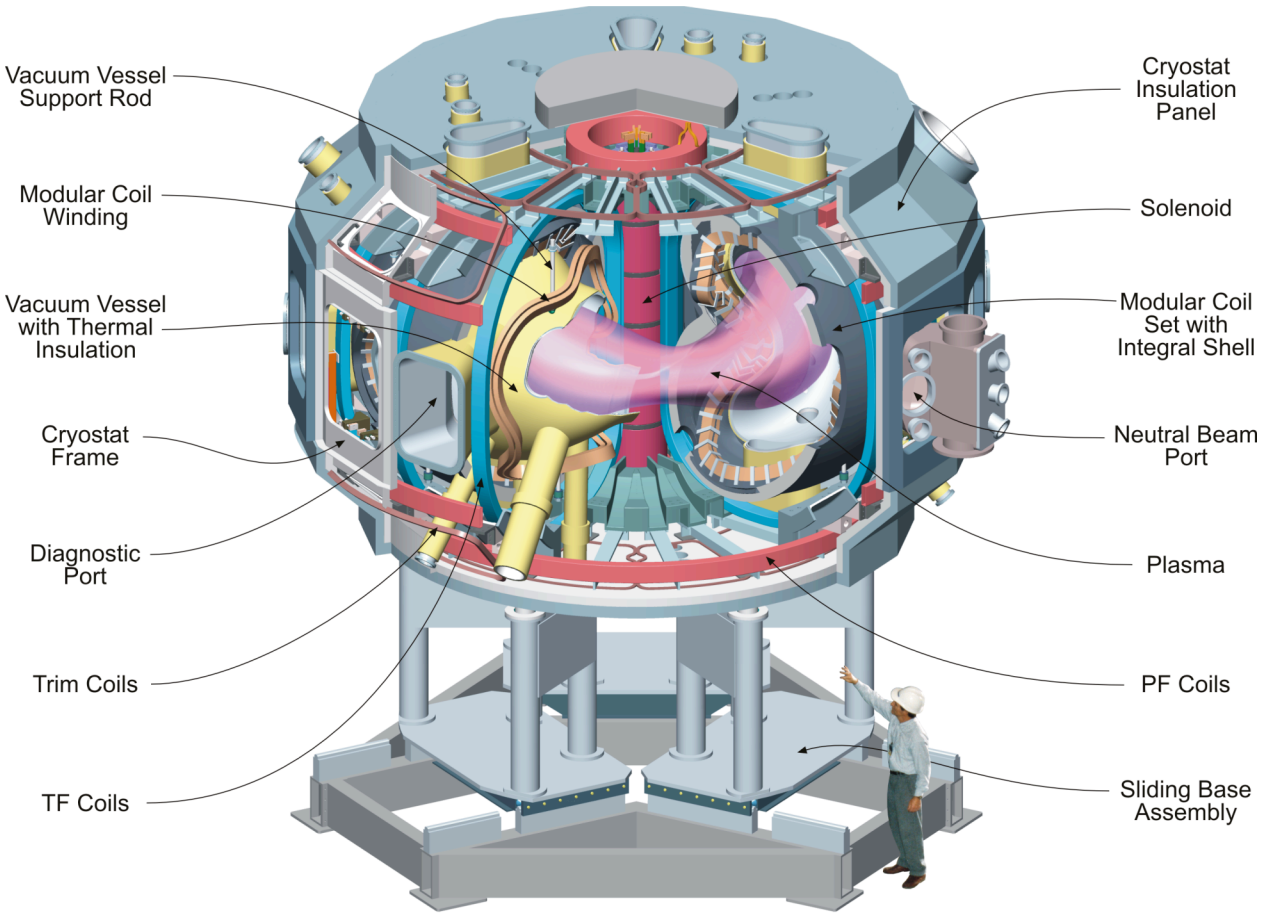
for the

Technical, Cost, Schedule,
ES&H, and Management Review

of the

NATIONAL COMPACT STELLARATOR EXPERIMENT (NCSX) PROJECT

June 2004



NATIONAL COMPACT STELLARATOR EXPERIMENT (NCSX) PROJECT

EXECUTIVE SUMMARY

As requested by Dr. N. Anne Davies, Associate Director for Fusion Energy Sciences (OFES) in the Office of Science, a Department of Energy Independent Project Review of the National Compact Stellerator Experiment (NCSX) Major Item of Equipment was performed at Princeton Plasma Physics Laboratory (PPPL) on June 8-9, 2004. The purpose of the review was to assess the overall cost, schedule, management, and readiness of the NCSX project for Critical Decision (CD) 3, Approve Start of Construction. Specifically, the Committee was asked to determine if the design of the Modular Coil Winding Forms (MCWF) and the vacuum vessel were complete, likely to meet performance requirements, and ready for procurement; the project cost and schedule, including contingency, were credible and reasonable; and the technical and management plans and processes were available and adequate.

Overall, the Committee found that pending successful outcome of the Vacuum Vessel Sub-Assembly (VVSA) and MCWF procurement process, CD-3 approval for the NCSX project should be granted. The VVSA and MCWF designs satisfied the technical requirements and are ready for procurement and fabrication. There is also a strong project team that has appropriate management tools and processes in place. The cost and schedule, including the contingencies are reasonable at this stage of the project.

The NCSX project is an innovative magnetic fusion plasma configuration consisting of a stellarator core that has three field periods and is surrounded by eighteen modular coils (six per field period). A vacuum vessel fills the internal volume of the modular coils to provide the maximum space for plasma shape flexibility. The modular coils are supplemented by toroidal field, poloidal field, and trim coils. Diagnostic systems provide the detailed measurement of the plasma parameters that are critical to the research goals of NCSX.

The Total Estimated Cost for the NCSX project reported to the Committee is $86.3 million including escalation and contingency. The project has expended approximately $13.8 million for activities leading up to the end of April 2004. Contingency remaining is $14.7 million, which is approximately 25 percent of remaining project costs. The project is scheduled for completion in May 2008 and includes five-and-a-half months of schedule contingency.

The Committee's major recommendations included:

- The project should consider offering incentive fee for on-schedule delivery of VVSA;
- Develop an option strategy for the MCWF procurement to provide for splitting orders

among competing vendors prior to receipt of bids;
- OFES should give high priority to sustaining the project's BA funding profile, especially in FY 2006;
- Update project baseline cost and schedule reflecting the actual proposal from MCWF and VVSA vendors after receipt of bids in July 2004; and
- Consider instituting a monthly project-specific status teleconference which should include PPPL, Oak Ridge National Laboratory, Princeton Site Office, and OFES personnel

There were no action items resulting from the review.

CONTENTS

1. INTRODUCTION

The National Compact Stellarator Experiment (NCSX) is a fusion research project initiated in the Department of Energy (DOE) FY 2003 budget for fabrication at the Princeton Plasma Physics Laboratory (PPPL). The compact stellarator is one of several innovative magnetic fusion plasma configurations supported by the DOE Office of Fusion Energy Sciences (OFES) and has the attractive potential of operating continuously and without plasma disruptions. Also, when extrapolated to a fusion power plant, the compact stellarator is projected to require low operating power compared with that produced by the power plant.

The mission of NCSX is to acquire the scientific and technological knowledge needed for understanding the behavior of a compact stellarator plasma, evaluating the attractiveness of this fusion concept, and advancing the state-of-the-art, three-dimensional analysis of fusion plasmas. The NCSX Critical Decision (CD) 0, Approve Mission Need, was obtained by OFES in May 2001. CD-1, Approve Alternative Selection and Cost Range, was obtained in November 2002. The lengthy Continuing Resolution in FY 2003 delayed this "new start" project, and Title 1 design did not commence until April 2003. Three major reviews, all of which were pre-requisites to CD-2, Approve Performance Baseline, were completed in the October-November 2003 time frame. These included the Preliminary Design Review conducted by PPPL, a Performance Baseline Review conducted by the Office of Science Construction Management and Support Division, and an External Independent Review conducted by the DOE Office of Engineering and Construction Management (OECM). All three of these review committees enthusiastically endorsed the project as being ready for CD-2. CD-2 was obtained in February 2004. The Total Estimated Cost (TEC) of NCSX is $86.3 million with completion expected in May 2008.

The NCSX project involves the design, fabrication, installation, and integrated system tests of a compact stellarator core device consisting of a highly shaped vacuum vessel; surrounding coil systems; enclosing cryostat and various auxiliary power, cooling, vacuum, cryogenic, and control systems; as well as a set of startup diagnostics. All of this equipment, plus a control room will be located in existing buildings at PPPL that were previously used for other fusion experiments. Further, many of the NCSX auxiliary systems will be made available to the project from equipment used on previous experiments. Because the project involves the fabrication of new equipment and considerable re-use of existing facilities and hardware systems and minimal civil construction, DOE designated the project as a Major Item of Equipment (MIE). The project will be led by PPPL with Oak Ridge National Laboratory (ORNL) providing major leadership and support as a partner.

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2. TECHNICAL SYSTEMS EVALUATIONS

2.1 Findings

The technical design has been extensively reviewed. In particular, a Final Design Review (FDR) was held May 19-20, 2004, and found that, "The designs of the Vacuum Vessel Sub-Assembly (VVSA) and the Modular Coil Winding Forms (MCWF) satisfy the technical requirements and needs of the project and are ready to proceed with procurement and fabrication." The FDR panel made 28 recommendations in the areas of procurement, specification of requirements, design, and R&D. Many of the recommendations have been resolved and those remaining are being aggressively pursued. The recommendations that affect release of technical data to the vendors have already been dispositioned.

The VVSA and the MCWFs are challenging components and contribute the bulk of technical, cost, and schedule risk to the project. Therefore, the MCWF is on the critical path, closely followed by the VVSA. Both have complex shapes and demanding tolerances given their size and complexity. Much work has been done to mitigate the risks. At this time, two vendors have been identified for each of these components and two vessel prototypes have been delivered and both MCWF prototypes have been cast. Shipment of a fully machined prototype from one vendor is due in July 2004 and the other is due in late August 2004. All four teams are beginning to work on the final fixed price and schedule proposals for the production components.

Vacuum Vessel Sub-Assembly (VVSA)

Because of its complexity and its proximity to being on the project's critical path schedule, considerable attention has been focused on the VVSA. The VVSA will be manufactured from Inconel alloy 625 in three symmetric sectors. During assembly at PPPL, the modular coils will be rotated over each vessel sector, and port extensions that provide access for plasma heating and diagnostics will be welded in place. The three sectors are joined together with field welds.

The NCSX project has engaged two vendors to separately manufacture 20 degree VVSA prototypes. Both prototypes were successfully fabricated and have recently been received at PPPL. Through this activity the NCSX project and its two prospective vendors for the VVSA were able to demonstrate the manufacturability of the design. This process will minimize

uncertainties in the VVSA acquisition, thereby ensuring more realistic cost and schedule bids, i.e. without this prototype activity, the bidders would likely have provided a large amount of cost and schedule padding.

The VVSA was one of the major elements reviewed at the NCSX FDR held in May 2004. The FDR found that the VVSA design satisfies the technical requirements and needs of the project and is ready to proceed with procurement and fabrication. Fourteen recommendations, developed during the FDR, were provided to the NCSX team to improve the design and the procurement strategies and further reduce the risks associated with VVSA delivery.

The Committee concurs with this finding, and furthermore finds that the project has taken appropriate measures to address all FDR recommendations to the extent possible at this time.

Regarding the four charge items as they relate to the VVSA:

1. Based on material presented at this review along with the outcomes of previous reviews, and the success of the vacuum vessel prototyping activity, the design of the vacuum vessel is judged to be complete, likely to meet its performance requirements, and ready for procurement. Technical issues, such as leak checking, weld inspection, and R&D for the VVSA field weld joint have been identified and are being adequately addressed.

2. Close interactions between the NCSX project team and the two prospective vendors who are engaged in the VVSA prototyping process has greatly reduced the technical, cost, and schedule uncertainty associated with fabrication of the vacuum vessel. Plans are reasonable and resources are adequate.

3. Management of the vacuum vessel design, procurement, assembly, and testing activities is excellent.

4. The project is ready to proceed to procurement of the VVSA.

Modular Coil Winding Forms (MCWF)

The Modular Coil Set consists of three field periods with six coils per period for a total of 18 coils. Due to symmetry, only three different coil shapes are required to make up the complete set. Each modular coil is constructed by winding pre-insulated rectangular compacted

copper cable onto a single stainless steel case winding form. Each coil consists of two double pancake windings. Once wound, the entire coil will be vacuum-pressure impregnated with epoxy. The winding forms are bolted together to form a complete torus and are electrically insulated from each other at the bolted interfaces. The coil set will be pre-cooled to cryogenic temperatures before each experimental pulse by helium or nitrogen gas.

Both teams have developed a manufacturing, inspection, test, and quality assurance (MIT/QA) plan and are using it to fabricate the prototypes.

Proposals are due in July 2004 and production subcontracts will be signed by the end of August. Evaluation criteria include experience gained in working with subcontractors during the development of the prototypes. Delivery of the second MCWF prototype is not due until the subcontract is signed.

The total cost of the MCWF is approximately $20.5 million with 40 percent contingency. At this time the cost is expected to increase by 20 percent.

2.2 Comments

Vacuum Vessel Sub-Assembly (VVSA)

Some FDR recommendations require further action. The project's action item tracking log appears to be an excellent tool to ensure that all review recommendations are addressed in an expedient manner.

The NCSX project is especially encouraged to follow through on its plans for R&D on the field weld joint that will be used to join the three 120 degree VVSA sectors.

Fracture mechanics/fatigue analysis issue identified during FDR must also be investigated and resolved.

Modular Coil Winding Forms (MCWF)

Early interaction with the vendors in prototyping will contribute significantly to reducing cost and schedule risk associated with the major components. Joint development of the MIT/QA plans has helped to ensure mutual understanding between NCSX and the potential vendors. All issues necessary to proceed with procurement have been resolved.

The delay in the delivery of the second MCWF prototype will not allow full evaluation of the second vendor but should be sufficient to result in a valid bid from the vendor and still allow NCSX to make an informed evaluation of the proposal. Procurement action should continue with the understanding that the project team and the DOE contracting officer will assess adequacy of vendor progress and results prior to final award action.

NCSX is considering the possibility of splitting the MCWF procurement to reduce schedule risk. Consideration should be given to possible impact on cost and funding profile.

2.3 Recommendations

1. Consider offering an incentive fee for on-schedule delivery of the VVSA.

2. Develop a split-order options strategy for the MCWF procurement prior to receipt of bids.

3. COST ESTIMATE

3.1 Findings

The Total Estimated Cost (TEC) for the NCSX is $86.3 million. The project has expended approximately $13.8 million for activities up to the end of April 2004. There is approximately $14.7 million in contingency, which as a percentage of remaining project cost is about 25 percent. The project has spent $1.19 million in contingency since the November 2003 DOE review to the end of April 2004.

The biggest cost risk currently is the price for the production of VVSA and MCWF that will be better defined after firm, fixed-price proposals from the vendors are submitted in July 2004 for both items. Based on current information, it is estimated that the quotes will come in approximately 20 percent higher than the base cost. This is well below the estimated 40 percent contingency that has been planned for production of VVSA and MCWF.

The staff needed for the project has been budgeted until May 2006 and this "standing army" cost ranges from $200-250K per month. For every month the project completes ahead of schedule, there is potential saving of $200-250K per month.

3.2 Comments

Cost estimates and contingency at this stage of the project appears reasonable. Also, the project will perform detailed estimate-to-complete estimates annually. However, the cost estimates and contingency for the remainder of the project may need to be updated after the proposals for MCWF and VVSA are submitted, especially if the costs are dramatically different from what was planned.

Following the submission of the proposals, the project still has activities such as the assembly of the vacuum vessels, winding of the modular coils, and the installation and assembly of the stellerator core, which poses high risk to the project. As a result, ensuring adequate contingency is important for successful completion of the project.

The project needs to pay close attention to availability and adequacy of funding, in particular during FY 2005-2006, since most of the high-risk work described above will be performed at this time. The project is evaluating options such as moving non-critical items

activities for later work, rearranging the order of work to be performed, and finding work efficiencies to minimize the impact of the funding limitations in FY 2005-2006. The Committee felt that the project should continue to evaluate these methods. The challenge for the NCSX is that there is little scope contingency and flexibility that can be used to find savings for the project.

The Committee is also concerned about the increase in price of and potential delivery delays for commodities (i.e., nickel, steel, Inconel, etc.) that the project will need. In response to this concern, project personnel expressed that the majority of cost for the remainder of the project will be labor cost and the cost impact of the higher commodities is small compared to labor costs. The project personnel also stated that the vendors are purchasing these commodities on a regular basis, which will minimize the cost impact due to "dollar cost averaging" effect of gradual procurement instead of one time purchase of materials. Additionally, the project felt that these prices are beyond the control of the project and predicting the future prices of commodities is not possible.

In the event that the there are potential delays in the winding and manufacturing of modular coils, the project is planning to utilize a second shift and over-time work to make up or accelerate the schedule. The project should consider evaluating the limitations of current schedule acceleration plan and reexamine the cost impacts of various options available.

3.3 Recommendations

None.

4. SCHEDULE and FUNDING

4.1 Findings

The NCSX baseline schedule remains credible and it has been developed in further detail since CD-2 was approved in February 2004. Fabrication of the MCWF and winding the Modular Coils are still the two major activities on the project's critical path. Since the schedule is only a little over three months off of the critical path, delivering the VVSA will also be very important to the overall success of achieving the CD-4, Approve Start of Operations, schedule milestone in May 2008. The Modular Coil winding schedule appears to be reasonably conservative because it does not assume the benefit of a learning curve. That is, the later coils are assumed to take just as long to wind as the first ones. PPPL plans to undertake the coil winding in-house since it is a process with which they have past experience.

There will continue to be a significant degree of uncertainty in the critical path schedule until the industrial contracts are placed for the MCWF and the VVSA (in about August 2004). Beyond that point, the Stellarator Core activities during FY 2005-2006 will be the key determinant in resolving many of the remaining uncertainties and setting the pace for project schedule performance.

When CD-2 was approved, the project's Budget Authority (BA) profile was flattened by reducing the previously planned funding level in FY 2005 by $4.5 million, and the schedule was stretched into FY 2008. As observed at the November 2003 DOE review, the annual budgeted contingency is skewed toward the project's end. The baseline funding profile is shown below.

NCSX Baseline Funding Profile
and Available Contingency Budgeted by Year ($M as spent)

	FY03	FY04	FY05	FY06	FY07	FY08	Totals
Scope	5.9	15.3	15.9	20.4	12.2	1.9	71.6
Contingency	2.0	0.6	0	1.7	7.2	3.2	14.7
Total Estimated Cost	7.9	15.9	15.9	22.1	19.4	5.1	86.3

The project's schedule performance since the November 2003 DOE review has been good. All of the Level 2 Milestones since CD-2 have been met, and the cumulative Schedule Performance Index is 0.95 (with a recently improving trend). There has been some slippage in non-critical path tasks, as well as in delivery of the MCWF prototypes (one from each of the two vendors). The project stated that although those prototypes were running late (delivery is

forecast to be in August 2004), they were far enough along that most of the necessary technical information is already or would soon be available to support the procurement schedule for the production items.

The NCSX commissioning schedule appears to be reasonable based on PPPL experience with commissioning National Spherical Torus Experiment (NSTX), which is a similar scale experimental device that was built just a few years ago. The Committee noted that per a previous DOE review recommendation, e-beam mapping is now included in the commissioning schedule.

Overall, the project schedule contains a contingency of five-and-a-half months. Given that CD-4 is planned to be in May 2008—that would support a project early finish date in December 2007. It should be noted that the steady-state project staff is budgeted though CD-4.

4.2 Comments

Given the nature of the critical path schedule that requires serial activities of producing the Winding Forms, winding the Modular Coils, and then assembling them with the VVSA into the Stellarator Core, the project's five-and-a-half months of contingency is appropriate (i.e., not overly generous).

The second Modular Coil winding station and the potential for a second shift of winding operations together provide flexibility to recover from some types of schedule delays in the Modular Coil production process. Nonetheless, Modular Coil production will almost certainly be paced by the Winding Form vendor(s)' output rate, which is estimated to be one Winding Form per month.

Flattening the project's BA funding profile by reducing the FY 2005 funding level by $4.5 million has significantly limited the flexibility of NCSX management to address the component fabrication, assembly, and testing issues that will inevitably arise. There is only $4.3 million of contingency that can be used before FY 2007 without deferring scheduled work that is not on the critical path. This is only about 30 percent of the total project contingency. The project estimates that such deferrals can only generate another $1 to 2 million of contingency "head-room" prior to FY 2007, and of course this would push other activities much closer to the critical path. Unfortunately, the FY 2005-2006 period is the most crucial time for fabrication of the Stellarator Core components, and will thus be the time when contingency is likely to be most needed.

Demand, and hence cost, for many construction commodities such as steel, Inconel, copper, and electrical equipment have substantially increased worldwide. Since NCSX costs are labor dominated, the overall cost impact may well be modest. However, the availability of some of these items (at any cost) for NCSX could potentially become a schedule issue.

4.3 Recommendations

1. OFES should give high priority to sustaining the project's BA funding profile, especially in FY 2006.

2. Update the project baseline schedule to reflect the actual vendor delivery schedules for the MCWF and VVSA components as soon as they become known.

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5. MANAGEMENT

5.1 Findings

The NCSX project is approximately 20 percent complete and is generally tracking the baseline plan.

A strong Integrated Project Team is in place, both management and technical, which has a clear understanding of the scope and challenges of the project.

Tools and processes to manage project activities are in place and functioning effectively. While there are a number of communications forums in place among PPPL, the Princeton Site Office (PSO) and OFES, none of these cover project specific details.

PPPL and ORNL management have placed a very high priority on NCSX and provides regular oversight of the project. Several staffing actions were taken since the November 2003 DOE review to assign additional personnel to the project.

A process is in place to identify and address critical issues (technical, cost, schedule) that could potentially impact the project. This process is central to risk management of the project.

The two critical procurements (MCWF and VVSA) are in progress and should be ready for award by the end of August 2004.

Since the November 2003 DOE review, the project scope was increased to include several preoperational testing activities. Safety related tasks and readiness reviews are now incorporated into the baseline to reflect this.

5.2 Comments

The integration between ORNL and PPPL seems to be working seamlessly.

Although personnel resource margins are tight, no issues involving institutional priorities were identified. In some cases additional short-term resources were made available to the project through ORNL.

The MCWF and VVSA procurements are planned as “best value” procurements. Care

should be taken in specifying the detailed procurement process to assure that management has the flexibility to meet the intent of the best value process.

Management should ensure that the critical issues list stays current with project status and other events that could be important. For example, the nationwide shortage of basic materials and commodities could impact NCSX, but was not recognized in the critical issues list.

The project should develop a critical spares plan; including whether to buy a spare casting of each of the three types of modular coil winding structure. Such a spare could help minimize the time necessary to recover from a potential problem that might arise in fabrication or operations.

Planning for pre-operations seems reasonable and consistent with the hazards of fusion devices of this scale.

5.3 Recommendations

1. Consider instituting regular (e.g., monthly) project specific status telecoms among PPPL/ORNL, PSO, and OFES.

2. Pending successful outcome of the VVSA and MCWF procurement process, CD-3, Approve Start of Construction, should be granted.

APPENDIX A

CHARGE MEMORANDUM

April 13, 2004

MEMORANDUM FOR Daniel R. Lehman, Director
Construction Management Support Division

FROM: N. Anne Davies
Associate Director for Fusion Energy Sciences

SUBJECT: Review of the National Compact Stellarator Experiment (NCSX) at the Princeton Plasma Physics Laboratory (PPPL)

I would like to request your office organize and lead an Office of Science (SC) review of the NCSX project.

The purpose of ths review is for SC to conduct an independent project rview to assess the overall cost, schedule, management, and readiness of the NCSX project for Critical Decision 3 (CD-3), Approve Start of Construction.

The review shall be conducted on June 8-9, 2004, at PPPL. Given the stage of the project, the review committee is requested to respond to the following questions.

1. Is the design, particularly the modular coil winding forms and the vacuum vessel, complete and likely to meet performance requirements? Are the modular coil winding forms and vacuum vessel ready for procurement? Are there credible plans for resolving any remaining technical issues?

2. Are the project cost and schedule, including contingency, credible and reasonable? Are there reasonable plans and adequate resources available to support the planned NCSX work?

3. Are management plans adequate? Are project control processes including change control systems, in place and functioning adequately?

4. Is the project ready to proceed to CD-3, Approve Start of Construction?

Gene Nardella, NCSX program manager, will work closely with you as necessary to plan and carry out this review. I would appreciate receiving your Committee's report within 45 days of the conclusion of the review. This review will play an important role in ensuring that the NCSX project can be completed on cost and schedule. Thank you for your help in this matter. If you have any questions or need additional information, please contact Gene at 3-4956.

APPENDIX B

REVIEW PARTICIPANTS

Department of Energy Review of the
National Compact Stellarator Experiment (NCSX)

REVIEW COMMITTEE PARTICIPANTS

Department of Energy

Stephen Meador, DOE/SC, Chair
Kin Chao, DOE/SC

Consultants

Steve Gourlay, LBNL
John Haines, ORNL
Jeff Hoy, DOE/SC
Les Price, DOE/ORO

Observers

Greg Pitonak, DOE/PAO

APPENDIX C

REVIEW AGENDA

Department of Energy Review of the
National Compact Stellarator Experiment (NCSX)

DRAFT AGENDA

Tuesday Morning, June 8, 2004—Lyman Spitzer Building, Room 318

8:00 am	DOE Executive Session	S. Meador
	FES Program Perspective--Charge	G. Nardella
	DOE Federal Project Manager Perspective	G. Pitonak
8:45 am	PPPL Welcome	R. Goldston
9:00 am	NCSX Project Status and Management Overview	H. Neilson
9:30 am	Design Status: FDR Results; WBS 12 (VV) and 14 (MCWF) summary	B. Nelson
10:00 am	Break	
10:15 am	Plans for Procurement and Fabrication	P. Heitzenroeder
10:45 am	Engineering Management Plans, Change Control	W. Reiersen
11:15 am	Cost, Schedule, and Project Control Overview (incl. EVMS metrics)	R Strykowsky
12:00 pm	Lunch	
	WBS Summaries (Technical, Cost, Schedule, Staffing, Management Issues)	
	WBS	
1:00 pm	Modular Coil Windings — 14	J. Chrzanowski
1:20 pm	Conventional Coils and Structures — 13/15	M. Kalish
1:35 pm	Balance of Stellarator Core — 16/17/18/19	B. Nelson
1:50 pm	Test Cell Preparation / Machine Assembly — 7	E. Perry
2:10 pm	Power Systems — 4	S. Ramakrishnan
2:20 pm	Ancillary Systems — 2/3/5/6	L. Dudek
2:30 pm	Startup & Operational Readiness Assessment — 85	C. Gentile
2:40 pm	Management and Integration — 8	H. Neilson
4:00 pm	Committee Working Session (w/ NCSX presenters as needed)	
5:00 pm	DOE Executive Session	S. Meador
6:00 pm	Adjourn	

Wednesday, June 9, 2004— Rooms 318

8:00 am	DOE Executive Session and Report Writing	
11:30 am	Closeout Dry Run	S. Meador
12:30 pm	Lunch	
1:30 pm	Closeout Briefing with NCSX Management	S. Meador
2:00 pm	Adjourn	

APPENDIX D

COST TABLE

Changes to NCSX Cost Baseline Through April 2004

WBS		CD-2 Baseline Jan 04 BAC	(From Jan 04) $	(From Jan 04) %	ECP-6 (April 2004) Changes	ECP-6 (April 2004) BAC
11	Limiters	$8			*$0*	$8
12	Vacuum Vessel	$6,065	$1,776	39%	*$835*	$6,900
13	Conventional Coils	$4,168	$1,023	26%	*$53*	$4,221
14	Modular Coils	$20,548	$5,823	34%	*-$53*	$20,495
15	Structures	$1,450	$441	31%	*-$14*	$1,436
16	Coil Services	$1,037	$249	24%	*$0*	$1,037
17	Cryostat & Base Sprt Struct	$1,306	$365	28%	*-$6*	$1,300
18	Field Period Assembly	$5,110	$1,471	29%	*$54*	$5,164
19	Stellarator Core Mngmt/Integr	$2,663	$329	15%	*$2*	$2,665
1	Stellarator Core Systems	$42,355	$11,477	31%	*$871*	$43,226
2	Heating, Fueling & Vac Sys	$1,630	$205	14%	*$63*	$1,693
3	Diagnostics	$1,685	$399	27%	*$8*	$1,693
4	Electrical Power Systems	$5,325	$998	19%	*$6*	$5,331
5	Central I&C Systems	$2,580	$244	10%	*$0*	$2,580
6	Facility Systems	$2,039	$391	19%	*$32*	$2,071
7	Test Cell Prep/ Machine Assy	$4,254	$788	19%	*-$17*	$4,237
8	Project Oversight/Support	$10,566	$1,408	16%	*$227*	$10,793
subtotal		$70,434	$15,910	26%	*$1,190*	$71,624
Contingency		$15,910			*-$1,190*	*$14,720*
Pct of ETC		*25.7%*				*25.5%*
Total		$86,344				$86,344
Spent		$8,466	*thru Dec 04*		*thru Apr 04*	$13,830
ETC		$61,968				$57,794

APPENDIX E

SCHEDULE CHART

NCSX Summary Schedule