

ESAAB Baseline Review

for the

National Compact Stellarator Experiment (NCSX)

At Princeton Plasma Physics Laboratory

July 27, 2005

An NCSX Description

The NCSX is a fusion experiment that is being designed and constructed at the DOE's Princeton Plasma Physics Laboratory (PPPL). Its purpose is to develop the physics of compact stellarators, an innovative fusion confinement concept.

Device Ratings at CD-4:

Major radius: 1.4 m

Magnetic Field Strength (B):
1.6 T (0.2 s pulse) / 1.2 T (1.2 s)

Vacuum base pressure (p):
 8×10^{-8} torr

Flexible with good access

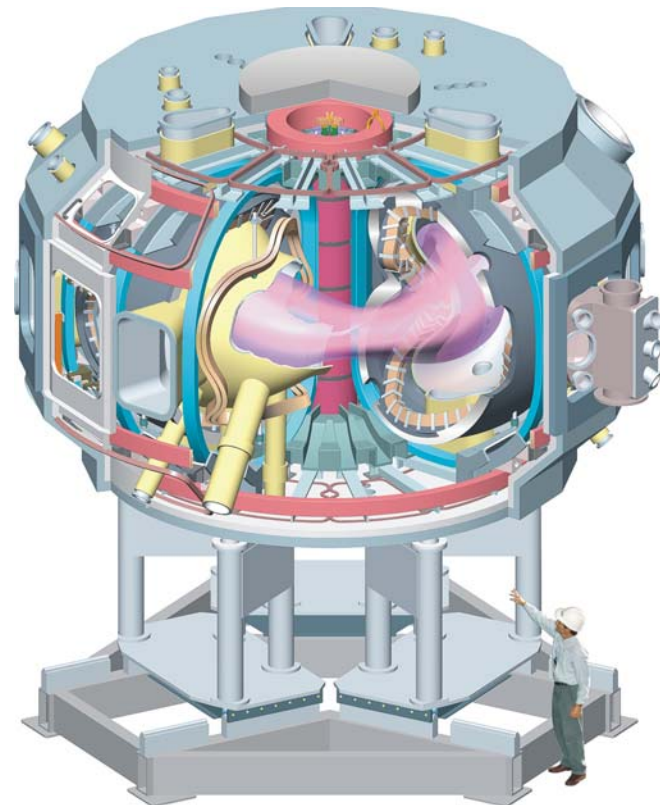
Full scope includes:

Stellarator device

Ancillary systems

Initial set of diagnostics

Control room



Mission Need

- Critical Decision 0 approved in May 2001:

“ The compact stellarator program addresses a critical issue for magnetic fusion energy,” namely the requirement for a magnetic plasma configuration that is stable at high plasma pressure.

Mission Need

Unlike tokamaks, stellarators are not susceptible to rapid, destabilizing loss of current.

Unlike conventional, large aspect ratio stellarators in Europe and Japan, compact stellarators extrapolate to reactors of the same size as tokamaks.

NCSX configuration was optimized through high performance computing. Cost effective test of physics compared to \$ billion EU and Japanese experiments.

ITER will address burning plasma physics for compact stellarator as well as for tokamak.

Purpose of Today's ESAAB Meeting

The NCSX Project has been directed by the Office of Science (SC) to re-baseline in response to its modified out year funding profile included in FY 2006 President's Request.

We are requesting your concurrence with new cost & schedule baselines, which will then be formalized using existing project control procedures.

Summary of Proposed Baseline Changes

✓ **Proposed New Baseline Parameters:**

- TEC Proposed: \$92.4M (+\$6.1M) TEC at CD-2: \$86.3M
- CD-4: July, 2009 (+14 mos.) CD-4 at CD-2: May 2008

✓ **The primary impact of the delay:**

- 1+ year delay in research opportunity and results from this device

✓ **The new baseline provides a sound plan for completing the project.**

- Supported by an up-to-date risk assessment.
- Provides sufficient budget contingency each year to manage risks as they develop.
- Maintains 5 months of schedule contingency.
- SC & Office of Engineering and Construction Management (OECM) reviewed the revised baseline on April 25, 2005.
- Meets the Mission Need established at CD-0.

New NCSX Baseline Responds to Revised DOE Annual Funding Guidance

New Budget Authorization (BA) profile shifts ~\$10M of FY06-07 funding to later years.

NCSX Major Item of Equipment (MIE) BA in \$M

	FY-03	FY-04	FY-05	FY-06	FY-07	FY-08	FY-09	TEC
CD-3 Baseline	7.9	15.9	15.9	22.1	19.4	5.1		86.3
New Baseline (ECP -031)	7.9	15.9	17.5	15.9	15.9	15.9	3.4	92.4
Delta/FY	0	0	1.6	(6.2)	(3.5)	10.8	3.4	6.1

- Because of reduced funding in FY 06 & 07, the project completion date will extend additional 14 months. This schedule addition will result in cost increase for overhead or level-of-effort personnel (in project management and control, engineering & design oversight, safety, & other costs (i.e., escalation, contingency) for the 14 months period.
- The current Five Year Office of Fusion Energy Sciences Outyear Budget Plan supports this new baseline

Summary of Changes

- **Proposed Baseline Parameters:**
 - TEC Proposed: \$92.4M (+\$6.1M)
 - TEC at CD-2: \$86.3M
 - CD-4 Proposed: July 2009 (+14 months)
 - CD-4 at CD-2: May 2008
- **The \$6.1M increase is the result of reduced annual funding includes the following:**
 - Management stretchout: \$1.2M
 - Job oversight & support stretch-out: \$1.2M
 - PPPL allocations stretch-out: \$0.4M
 - Escalation: \$0.5M
 - Rate increases due to reduced overall ops budget at PPPL: \$1.6M
 - Contingency (25%) on these increases: \$1.2M

Basis for NCSX FY 2006 Baseline Change

- The FY 2006 OMB Request included:
 - \$22.1 M for NCSX
 - \$46 M for ITER
 - Operations funding for three operational facilities - DIII-D at General Atomics, Alcator C-Mod at Massachusetts Institute of Technology, and National Spherical Torus Experiment (NSTX) at PPPL
- The FY 2006 President's Request included:
 - Reduction in **non-ITER** funding of ~**\$33M** from the FY 2005 Appropriation which was achieved by reductions (from the FY 2005 level) in the following areas:
 - (-\$1.6M) NCSX Major Item of Equipment funding
 - (-\$7.3M) Elimination of the Materials Research program
 - (-\$7.8M) Reduced operations weeks at DIII-D and Alcator C-Mod, and zero run weeks for the NSTX
 - (-\$4.2M) Reduction in Plasma Technologies Research
 - (-\$12.9M) Alternates Research and Other

Summary & Recommendation

- NCSX still has a long way to go.....
- Project is going reasonably well with significant subcontract awards in place, and production activities underway.
- Project staff & management are functioning well.
- The project has prepared new cost and schedule baselines in response to DOE-directed funding changes. A review by SC and OECM was conducted on April 25, 2005.
- Risk assessment has identified areas of risk going forward. Proposed contingency is adequate to manage these risks.
- SC-1 concurs with the new baseline
- ***We recommend approval to formalize new baselines using existing project control procedures.***

Backup

Progress in Production of Critical Components Has Reduced Risk

- Modular Coil Winding Forms (MCWF) by industry
 - Foundry has completed first casting – now being machined.
 - Three additional castings poured to date
 - Inspections underway
 - 2 of 3 casting molds are complete.
- Vacuum Vessel Sub Assembly (VVSA) by industry
 - Segmentation design chosen to minimize bends & welding.
 - All 10 die sets have been fabricated.
 - Material commitments have been secured.
 - Forming of shell panels has started (25% complete).
- Trial coil winding (by PPPL/Oak Ridge National Lab)
 - One-third scale trial winding completed.
 - Design & process improvements realized.
 - Cost variance has been retired.

Risk/Contingency analysis

Contingency available at CD-2 baseline --	\$15.90M	--	~26% of remaining work
Contingency available at 5/31/05 --	\$11.60M	--	~25% of remaining work
Proposed contingency going forward --	\$ 12.8M	--	~25% of remaining work

..... most contingency \$\$\$ allocations to date have been related to increased costs in MCWF & VVSA. This risk has been retired by signing fixed price contracts.

... ..delays on the first form of the MCWFs in all the major manufacturing steps- making the pattern for the mold, pouring the mold, and then the machining, have led to approximately a one month delay in the schedule. Process improvements on the second forms have already resulted in significant reductions in the process times for pattern production and pouring of molds. Similar improvements are also expected in the machining process for subsequent MCWFs once the first one is completed.

..... schedule contingency remains at ~5 months.

..... production risks are being retired – assembly risks are now the primary focus.

..... no other high level risks are anticipated....we are continually searching for the “unknown unknowns”

..... any further stretch-out of the funding profile will negatively affect the cost and schedule baselines.

Forward Contingency is Based on Risk Assessment

Contingency is supported by updated job-by-job risk assessment.

WBS	Work To Go (\$M)	Contingency (%)
VVSA Contract	3.8	10%
MCWF Contract	6.4	10%
Stellarator Core Balance	21.0	40%
Ancillary Systems, Final Assembly, and Startup	11.5	19%
Mgt. & System Engineering	8.8	14%
Total Work	51.5	
Contingency	12.8	25%

Contingency funding is spread to manage each year's risks.

<u>BA(\$M)</u>	<u>FY05</u>	<u>FY06</u>	<u>FY07</u>	<u>FY08</u>	<u>FY09</u>
Work	16.5	12.0	12.8	12.9	1.6
Contingency	1.0	3.9	3.1	3.0	1.8
Annual MIE	17.5	15.9	15.9	15.9	3.4

Summary risk assessment

- Modular coil winding risks were significantly reduced via winding R&D program.
Current risk management focus: parts availability, dimensional control.
- Toroidal Field coil quality and source availability risks reduced via design & planning changes.
- Project's risk management approach: Contingency applied when risks are retired.

Analysis of Remaining Risk Factors

- Risk – Fabrication of high tolerance components
 - *Mitigation – prototype production prior to vendor selection*
- Risk – Winding of modular coils
 - *Mitigation – Twisted Racetrack (1/3 scale) trial coil produced*
- Risk – Quality and performance of finished coils
 - *Mitigation – “make-or-buy” analysis leads to decision to wind both modular coils and toroidal field coils in house*
- Risk – Final assembly of highly shaped components
 - *Mitigation – extensive Computer Aided Design modeling of fixturing and assembly processes to insure early identification of potential conflicts*

Integrated Safety Management

- The project has maintained an exemplary safety record to date.
- PPPL hosted a lab-wide safety meeting in February, 2005. SC Electrical Safety review held at PPPL March 14 to 18. PPPL program described as a “model” for SC labs.
- Safety reviews continue to be completed prior to initiation of new project fabrication activities. Both DOE and PPPL personnel participate in the reviews.

Technical Accomplishments Provide a Sound Basis for Forward Planning

Progress in production and better understanding leads to reduced risks.

From November thru May, we accomplished ~\$10M of work.

- Progress in R&D, design, tooling, and component production.
- Project work is 38% complete.
- As of May 2005, CPI=0.97 and SPI=0.96

Risks have been re-assessed based on technical progress.

- Some risks have been reduced or retired.
- Remaining risks are better understood.
- No new/unexpected risks have been identified.

The Integrated Project Team will continue with a risk management approach that is working well.

- Continually identify, assess, and track risks. (Critical Issues list.)
- Continually mitigate risks through engineering and planning improvements.
- Apply contingency when risks are retired.

The new baseline incorporates what we have learned to date.

- Planning changes are being incorporated to reduce future cost/schedule risk.