# NSTX Upgrade Project
# Acquisition Strategy

April 5, 2010

## Change Log

| Rev. | Date | Change Description | Pages |
|---|---|---|---|
| 0 | 1/11/10 | Initial issue by PPPL & PSO | |
| 0.1 | 4/5/10 | Cost and Schedule range changes and incorporated comments from SC-OFES and SC-OPA . | 3-5 |

## SUMMARY PROJECT INFORMATION

| | |
|---|---|
| Project Title: | NSTX Upgrade Project at PPPL |
| Total Project Cost (TPC) Range: | $74.7M to $92.9M |
| CD-0 Mission Need Approved: | February 23, 2009 |
| CD-0 Approving Official: | Dr. Patricia Dehmer,<br>Deputy Director of Science Program<br>for the Office of Science |
| CD-0 Material Change: | None |

## 1.0 Desired Outcome, Requirements, and Major Applicable Conditions

### 1.1 Project Description

This is a hardware upgrade to an existing, operating fusion research device located at PPPL. The deliverable of this project is to design, build and install a new Centerstack for NSTX and install a second Neutral Beamline on NSTX.

The purpose of the NSTX Centerstack Upgrade is to expand the NSTX operational space and thereby the physics basis for the next-step ST facilities. The new centerstack will provide a toroidal magnetic field at the major radius of 1 Tesla compared to 0.55 Tesla in the original NSTX device, and will enable operation at plasma current up to 2 Mega-Amp compared to the 1 Mega-Amp rating of the original device.

A second TFTR neutral beamline will be decontaminated, reconditioned to the same status as the existing beamline on NSTX, and installed at Bay K of NSTX in such a way that its three beams are more tangential to the machine's radii than beamline #1. Beamline #1 and beamline #2 shall be configured so they can operate together or separately to support experiments.

### 1.2 Performance Parameters Required to Obtain Desired Outcome

The project is defined as complete and objectives met when the new centerstack provides the capability of a toroidal magnetic field at the major radius of 1 Tesla compared to 0.55 Tesla in the original NSTX device, and will enable operation at plasma current up to 2 Mega-Amp compared to the 1 Mega-Amp rating of the original device.

A second TFTR neutral beamline will be decontaminated, reconditioned to the same status as the existing beamline on NSTX, and installed at Bay K of NSTX in such a way that its three beams are more tangential to the machine's radii than beamline #1.  Beamline #1 and beamline #2 shall be configured so they can operate together or separately to support experiments.

More detailed parameters are covered in the General Requirements Document for the Centerstack Upgrade and in the General Requirements Document of installing a second Neutral Beam on NSTX.

### 1.3 Environmental, Regulatory, and Technology Development

No environmental, regulatory or technology development issues have been identified.

## 2.0 Cost and Schedule Range

### 2.1 Total Project Cost Range

The preliminary total project cost (TPC) range is $74.7M - $92.9M.

### 2.2 Funding Profile

Table 1. NSTX Upgrade Project Preliminary Funding Profile (TPC $K)

**$K**

| | FY 2009 | FY 2010 | FY 2011 | FY 2012 | FY 2013 | FY 2014 | FY 2015 | TOTAL |
|---|---|---|---|---|---|---|---|---|
| **OFES Program Guidance** | | **$47,900 (1)** | **$48,258** | **$49,847** | **$52,844** | **$54,336** | **$50,657** | |
| **LOW RANGE** | | | | | **OUTAGE** | | | |
| **Base Estimate** | $5,146 | $8,346 | $7,644 | $14,449 | $22,843 | $9,721 | | $68,149 |
| **Contingency** | | 8% | 11% | 9% | 8% | 20% | | **10%** |
| **Total Required** | $5,146 | $9,000 | $8,450 | $15,740 | $24,651 | $11,690 | | **$74,677** |
| **BA Available for Project** | $5,146 | $9,000 | $8,450 | $15,740 | $27,150 | $26,200 | | |
| **HIGH RANGE** | | | | | **OUTAGE** | | | |
| **Base Estimate** | $5,146 | $7,617 | $7,111 | $11,655 | $19,629 | $18,623 | $0 | $69,781 |
| **Contingency** | | 18% | 19% | 35% | 38% | 37% | | **36%** |
| **Total Required** | $5,146 | $9,000 | $8,450 | $15,740 | $27,150 | $25,503 | $1,888 | **$92,877** |
| **BA Available for Project** | $5,146 | $9,000 | $8,450 | $15,740 | $27,150 | $26,200 | $8,980 | |

(1) Reflects March fin plan plus FY09 PPPL c/o. Also includes $5.7M for collaborators

### 2.3 Key Milestones

| | **Low Cost Range** | **High Cost Range** |
|---|---|---|
| CDR | Oct-2009 | |
| Submit CD-1 Request | Jan-2010 | |
| Receive CD-1 Approval | Apr-2010 | |
| PDR | Jun-2010 | Aug-2010 |
| Submit CD-2 Request | Jul-2010 | Sep-2010 |
| Receive CD-2 Approval | Aug-2010 | Oct-2010 |
| FDR | Mar-2011 | May-2011 |
| Submit CD-3 Request | Apr-2011 | Jun-2011 |
| Receive CD-3 Approval | May-2011 | Jul-2011 |
| Complete Operations | Mar-2012 | Mar-2012 |
| Begin Outage | Apr-2012 | Apr-2012 |
| Complete Outage | May-2014 | Oct-2014 |
| CD-4 | Dec-2014 | May-2015 |

The cost and schedule range proposed above assumes the following;

- The extended maintenance period at the beginning of FY12 does not require a machine vent.
- No major repairs or upgrades are required after the FY11 run.
- Assumes a high level of efficiency transitioning the NSTX technicians and engineers between operations and the outage tasks in FY2012.

## 3.0 Alternatives and Risk Analysis

### 3.1 Technical Alternatives Analysis

Alternatives that cover the range of available technical approaches are as follows:

Alternative 1: Do nothing

Alternative 2: Upgrade Centerstack and add second Neutral Beamline

Alternative 3: Upgrade Centerstack only

Alternative 4: Upgrade Centerstack and later add a Neutral Beamline

The advantages and disadvantages for each of these three alternatives are summarized below:

| Alternative | Advantage | Disadvantage |
|---|---|---|
| #1 | None | No new science |
| #2 | New science (desired) | None |
| #3 | Lower project cost | Minimal new science |
| #4 | Project cost spread out | Increased total cost /<br>No operations for 4 years |

### 3.2 Location Alternative Analysis

There are no location alternatives available for consideration because this is an upgrade to an existing device.

### 3.3 Total Lifecycle Costs

This project is an upgrade to an existing facility and it will extend the life of the facility and hence extend the present maintenance and repair costs. This upgrade will not substantially increase the cost of decommissioning the facility. Table 3-1 shows the alternate cost analysis.

### 3.4 Recommended Alternative

Alternate 1 was deemed unacceptable due to the lack of new science.

Alternate 2 is recommended as the preferred alternate because it is the most efficient use of capital funds, provides the desired science and maximizes the operational time for the existing NSTX facility.

Alternate 3 were deemed unacceptable because it minimizes the new science attainable.

Alternate 4 was deemed unacceptable because it requires four years of downtime for the NSTX facility.

**Other Acquisition Alternatives Considerations**

Various alternatives have been considered with respect to this project. One was to evaluate whether to build the new Centerstack at PPPL or to award a contract to a vendor to perform the fabrication. The other was to evaluate whether to decontaminate existing components of Neutral Beam #4 or to fabricate new ones.

It has been determined that the Centerstack should be fabricated at PPPL due to the fact that PPPL has the experience, having built the present Centerstack, and any issues with the fabrication process for this unique design could be handled most effectively in a setting where the engineers and designers who developed the design are available for immediate consultation if problems arise.

The decontamination of the neutral beam is being pursued to determine which components can be returned to a condition that is acceptable for use on NSTX, thereby saving the cost of fabricating new components.

The project also considered the use or collaborate with other ST facilities, such as MAST in the United Kingdom. Upgrades to the MAST device are being considered to narrow these gaps, and the upgraded MAST facility would likely surpass present NSTX capabilities in some parameters, such as maximum toroidal field strength. However, upgrades to the NSTX device would likely enable access to higher magnetic strength, non-inductive current drive fraction, and pulse duration than achievable in upgraded MAST. Further, even the upgraded MAST capabilities are not adequate to access very high normalized plasma pressure at low plasma collisionality needed to fully understand and exploit the ST parameter regime. Finally, the MAST facility is already heavily utilized by its present research team, and access for U.S. researchers would likely be limited.

## 3.5 Risk Analysis

While typical risk associated with design/fabrication projects have been tabulated in the project's risk registry and quantified in the project's contingency, the over arching risk that could jeopardize the cost and schedule baseline, and is outside the contractor's control, is as follows:

<u>Funding and Budget.</u>

Potential risk: Two risk items have been identified.

1. The impact of an annual prolonged continuing resolution affecting the Project's ability to ramp up spending or purchase critical hardware, and/or;

2. OFES directed re-baseline in response to changes in outyear funding assumptions.

Response:

In regards to concern #1 above, three mitigation strategies include:

a. All critical tasks will have sufficient free float to mitigate short term impacts of a continuing resolution;
b. PPPL has some degree of latitude to institutionally protect the impact of a continuing resolution on the NSTX Upgrade Project;
c. OFES may have the ability to reallocate interim funds to support the project, and;
d. The project is considered a 'major item of equipment'. Therefore, 'no new start' requirements common to continuing resolutions do not apply.

In regards to concern #2 above, a mitigation strategy would require OFES, as part of the CD-2 baseline commitment, to sequester necessary project funds to ensure uninterrupted funding is provided in support of the cost and schedule baseline.

Risk indentified: Moderate.

Other topical risk areas have been reviewed and determined to not pose major significant risk in the timely completion of this project within the cost and schedule range. Specifically, these topical risk areas are discussed in further detail as follows:

<u>Scope and Definition.</u>

Potential risk: The scope of work is not sufficiently defined, or the mission need is poorly defined resulting in changes in the project's scope and definition.

Response: The scope and definition of this project has been vetted by the NSTX Program Advisory Committee, an independent external conceptual design review, and an Office of Science independent review. Findings from these reviews/committees have validated the scope and definition of this project.

Risk identified: Low (unlikely).

<u>Functionality.</u>

Potential risk: The completed scope of work by the Upgrade Project will result in significant failure or loss of functionality to the NSTX device.

Response: Significant upfront planning includes a failure mode effects and analysis (FMEA). Extensive mechanical and thermal analysis of the postulated operational scenarios, review and update of system FMEAs, and the addition of a digital coil protection system will mitigate this risk. Further, the NSTX Upgrade project is an upgrade to an existing research device that has well understood systems and components. Further, this upgrade represents no new unproven systems or the addition of systems that would otherwise jeopardize the functionality of the NSTX research device.

Risk identified: Low (unlikely).

ES&H.

Potential risk: Upgrade results in the increased potential harm to site personnel, the public or the environment.

Response: The NSTX program at PPPL is an existing ongoing program that has well established ES&H procedures covered under the umbrella ES&H program at PPPL. The Upgrade Project is an augmentation to known NSTX operating systems which have been in operation for over 10 years. Further, NSTX is a below Hazard Category III facility and will remain so after the upgrade as per the Preliminary Hazard Analysis Report.

Risk identified: Low (unlikely).

Workforce Issues.

Potential risk: Skills necessary to support design, fabrication and testing are not available.

Response: Workforce is currently in place to support the project. In addition, the risk registry identifies a mitigation plan for the loss of key individual personnel. Any temporary acute shortages of technicians, or ramp up of technician labor, will be filled via subcontractors/BOAs if necessary as has been successfully done for other large projects at PPPL.

Risk identified: Low (unlikely).

Technology & Engineering.

Potential risk: New material or technologies must be developed.

Response: No new materials or technologies are required to complete the scope of this project. The project primarily consists of augmentation to existing NSTX components and ancillary systems. However, R&D and prototyping efforts are planned to validate conceptual design concepts.

Risk identified: Low (unlikely).

Interfaces & Integration Requirements.

Potential risk: Need to coordinate the shutdown of NSTX while installing new equipment.

Response: The NSTX Program at PPPL will continue to coordinate the necessary outage for construction phase of the Project. Any delays in work that require extension to the outage are within the internal management control of PPPL.

Risk identified: Low (unlikely).

<u>Safeguards and Security.</u>

Potential risk: New vulnerabilities in regards to safeguards and security have been created.

Response: The NSTX device is a below hazard Category III facility containing minimum radiological materials. Further, a security vulnerability assessment has been performed and concluded that no new vulnerabilities will be created by the Upgrade Project.

Risk identified: Low (unlikely).

<u>Location and Site Conditions.</u>

Potential risk: Adverse changes in NSTX Test Cell occur.

Response: NSTX is an established research program at PPPL with over 10 years of operation. The Upgrade Project will only require minimal modification to PPPL's infrastructure and does not require change in the size requirements inside the NSTX Test Cell.

Risk identified: Low (unlikely).

<u>Legal and Regulatory.</u>

Potential risk: External regulatory oversight and/or approval results in the delay to the execution, or modification, to the planned workscope.

Response: There is no external regulatory approval required for this work. NEPA determination (categorical exclusion) has already been approved.

Risk identified: Low (unlikely).

<u>Stakeholder Issues.</u>

Potential risk: External stakeholder involvement results in an impact to the project's scope, cost and schedule.

Response: Other than DOE, the only other significant stakeholder external to PPPL are the off-site scientific collaborators within the scientific community. However, the project's mission need has been vetted thru scientific colloquia and was approved by DOE.

Risk identified: Low (unlikely).

<u>Existence of Metrics for Performance Measurement.</u>

Potential risk: External metrics are missed as a result of poor project performance.

Response: There are no non-DOE (e.g., State or local regulatory, etc.) metrics that would be impacted by the performance of this project. There are DOE Office of Science metrics established annually for the operational run-weeks of the NSTX device, but the definition of the metrics are within the control of OFES.

Risk identified: Low (unlikely).

Required Government-furnished Property/Information and Its Availability.

Potential risk: Prompt receipt of government furnished property/information will jeopardize the project's cost and schedule.

Response: There are no plans to procure government furnished property or information.

Risk identified: Low (unlikely).

Expertise and Human Resources.

Potential risk: There is an inadequate level of expertise within DOE to carry out this acquisition.

Response: This project is governed by DOE Order 413.3A. In accordance with the order, appropriate DOE personnel are already in-place as fully described in the project's preliminary project execution plan.

Risk identified: Low (unlikely).

Table 3-1 Alternatives Analysis Life Cycle Costs

**Alternatives** (1) (4)

| | #1 | #2A | #2B | #2C | #5 | #6 |
|---|---|---|---|---|---|---|
| | Do Nothing-Operate existing machine | Upgrade CS and 2nd NBI | Upgrade CS only | Upgrade CS now and 2nd NBI later | Construct New device (green field cost) (5) | Collaborate with other ST facilities |
| Investment cost (escalated $M) | $0 | $94 | $60 | $100 | $314 | n/a |
| Machine operations (years) (2) (3) | 9 | 9 | 9 | 9 | 9 | n/a |
| Machine unavailable (years) | 0 | 2 | 2 | 4 | 5 | |
| Total program span (years) | 9 | 11 | 11 | 13 | 14 | |
| Operational, maintenance, research & collab. cost (@ $40M/yr escalated excl minor upgrades) during run year | $419 | $419 | $419 | $419 | $419 | n/a |
| Operational, maintenance, research & collab. cost (@ $24M/yr escalated excl minor upgrades) during outage | $0 | $51 | $51 | $105 | $127 | n/a |
| D&D (escalated $M) | $11 | $17 | $12 | $18 | $36 | n/a |
| **Total ($M)** | **$430** | **$580** | **$542** | **$641** | **$897** | **n/a** |
| **Advantage** | **None** | **Significantly closes capability gaps using an existing device. Most cost effective.** | **Address understanding causes of ST transport, scaling to next-steps** | **Same as 2A** | **Increased flexibility and/or design improvements** | **None** |
| **Disadvantage** | **Does not meet the DOE mission need and goals** | **Reduced flexibility/capability relative to a new ST device** | **Does not address increased aux heating and current drive reqmts** | **Same as 2A except less cost efficient and delays research program by 2 years** | **Cost and time for construction, disruption to ongoing ST research if existing ST facilities were not operated during the construction phase of a new ST facility.** | **No other ST facilities - including MAST facility - are adequate to close the capability gaps identified above.** |

**Notes:**

(1) Does not included minor incremental upgrades (~$5M/yr).

(2) Beneficial physics difficult to anticipate and quantify.

(3) Machine life not considered. Dependent on operational scenarios, no. of shots, & reliability, etc.

(4) All cost estimates except the selected upgrade cost are based upon high level mgt estimates and historical data.

(5) includes D&D cost of both the existing NSTX plus the new machine.

# 4.0 Business and Acquisition Approach

## 4.1 Contract Alternatives

Various alternatives have been considered with respect to this project. Due to the fact that a substantial amount of the work has been performed before at PPPL, it is recommended that the design and fabrication of non-off-the-shelf components be performed by experienced PPPL staff. Figure 4.1 shows a comparison of procured, subcontracts, and PPPL labor necessary to execute the project.

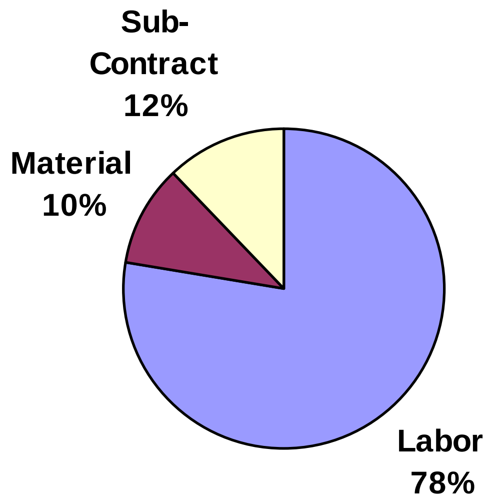



**Figure 4.1 Project cost breakdown**

### 4.2 Major Contracts Contemplated

PPPL will award contracts for the copper required to build the coils and center bundle, the Plasma Facing Components, cabling, and cable installations outside the Test Cell. Competitive selections will be based on demonstrated technical abilities, qualifications, capabilities and resource availability to meet the schedule requirements, as appropriate. Firm fixed price contracts are expected.

Existing Basic Ordering Agreements (BOAs) may be used to cover some of the standard trade work performed outside of the NSTX Test Cell.

### 4.3 Special Acquisition Procedures

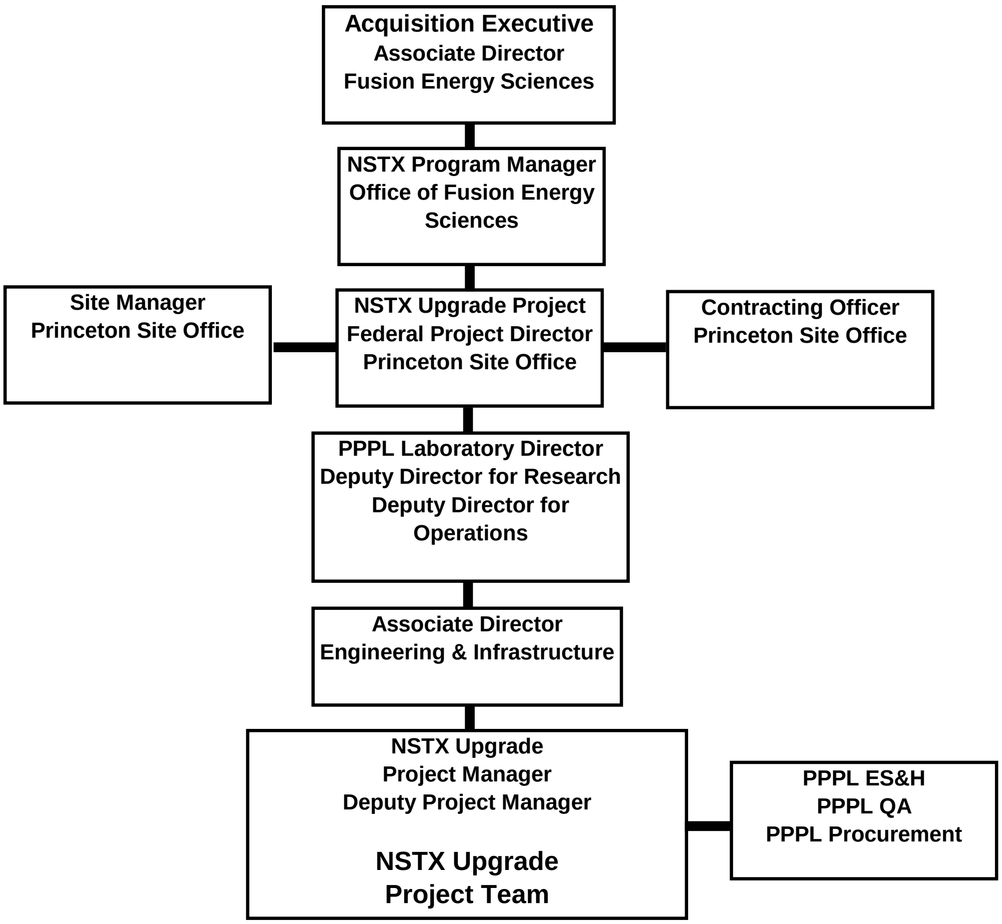
No special acquisition procedures will be used.

### 4.4 Performance Incentives/Small Business Approach

Solicitation will be made with consideration for small business, veteran owned small business, service disabled veteran-owned small business, HUB Zone small business, and small disadvantaged business and women-owned small business concerns. Awards will be based on the best value determined from an evaluation of the technical criteria such as technical qualifications, past performance and experience, as well as cost considerations.

## 5.0 Management Structure

### 5.1 Project Organization




**Integrated Project Team (IPT) Members**

- The NSTX Upgrade Project Federal Project Director
- The OFES NSTX Upgrade Project Program Manager
- The PPPL Associate Laboratory Director for Engineering and Infrastructure
- The NSTX Project Director
- The NSTX Program Director
- The NSTX Upgrade Project Laboratory Project Manager
- The PPPL Procurement Manager
- The NSTX Upgrade Project Quality Assurance Manager
- The NSTX Upgrade Project ES&H Manager
- The NSTX Upgrade Project Control Manager
- The NSTX Control Manager
- The NSTX Centerstack Upgrade Engineering Manager
- The NSTX Second Neutral Beam Engineering Manager

The membership of the Integrated Project Team will change as the project evolves into construction and system startup.

## 5.2 Approach to Performance Evaluation and Validation

DOE O 413.3A, *Program and Project Management for the Acquisition of Capital Assets*, will be used as the primary management tool and guideline to execute the project.

PPPL is implementing a certifiable EVMS that is compliant with ANSI/EIA-748-A-1998. This EVMS will be certified prior to CD-3, and will be implemented and used to monitor and evaluate project progress and performance for the duration of the project. The project will enter project status into Project Assessment and Reporting System (PARS) monthly and after the approval of CD-2, EVMS data will be provided in PARS.

A Primavera database, including estimated costs and resources, will be utilized to manage this project. Throughout the phases of this project, the Primavera database will be updated and refined to reflect the sequence of activities required to be accomplished within specific milestone completion dates and planned costs. The database will be updated monthly to document progress with respect to the performance durations and cost. The DOE site office will coordinate the preparation and submittal of any status reports required by DOE Headquarters.

### Change Control

The Project Execution Plan specifies a change control process, which has been used before at PPPL. This process identifies the change control authorities of DOE and PPPL that will be utilized to manage any required changes to cost, scope, or schedule.

### Project Reporting

Monthly reporting will be accomplished through the DOE Project Assessment and Reporting System (PARS). Quarterly reports will continue to be provided to SC-OFES.

### Project Meetings

PPPL will conduct regularly scheduled meetings and reviews to discuss project technical scope, schedule and cost status, and any emerging issues that may have an adverse impact on technical scope, schedule, or cost. Participants will include integrated project team representatives as deemed appropriate.

**SIGNATURES**

This report accurately represents the best thinking and efforts of the NSTX Upgrade Project and the NSTX Upgrade Project IPT to understand the full range of project risks and alternatives available to accomplish the project mission.

All reasonable risks and mitigations to executing the acquisition strategy have been included at this time, and the IPT believes the recommended acquisition strategy is in the best interest of DOE.

If new information or facts arise that could have a significant impact on the project's cost, schedule, or performance, the Federal Project Director will make the Program Secretarial Office and the Office of Engineering and Construction Management (OECM) aware of this in a timely manner.

This acquisition strategy may be revised when it makes good business sense to do so. Any changes must be justified and documented. Material changes to the acquisition strategy, such as changes in recommended alternative(s), risk profile, contract or competition approach, or major milestones, must be adequately documented and approved at the same approval level as the original document.

## Submission and Recommendation

**Submitted by the Princeton Plasma Physics Laboratory**

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Ronald L. Strykowsky, Project Manager, PPPL — Date

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**Recommended for Approval by the Department of Energy Princeton Site Office**

| | |
|---|---|
| Jeffrey Makiel, Federal Project Director, DOE-SC-PSO | 4/6/10 Date |
| Raymond Kimble, Contracting Officer, DOE-SC-PSO | 4/6/10 Date |
| Jerry Wm. Faul, Manager, Princeton Site Office, DOE-SC-PSO | 4/6/10 Date |

**Concurrence**

| | |
|---|---|
| Barry J. Sullivan<br>Program Manager, Office of Fusion Energy Sciences<br>Office of Science | 4/6/10 Date |
| Steven R. Eckstrand<br>Acting Division Director, Office of Fusion Energy Sciences<br>Office of Science | 4/6/10 Date |
| Daniel R. Lehman<br>Director, Office of Project Assessment<br>Office of Science | 4/7/10 Date |
| Edmund J. Synakowski<br>Associate Director for Fusion Energy Sciences<br>Office of Science | 4/6/10 Date |

**Approval:**

| | |
|---|---|
| Patricia M. Dehmer<br>Deputy Director for Science Programs<br>Office of Science | 4/10/10 |