

**June 23, 2004**

**ACQUISITION STRATEGY - SAMPLE AND GUIDANCE TOOL #3  
For A Typical Infrastructure Upgrade Project, Major Item of Equipment**

**Project Title: Quasi-Poloidal Stellarator Upgrade Project**

**Lead Program & Project Office: Office of Science, Office of Fusion Energy Sciences  
DOE Oak Ridge National Lab Site Office**

**Total Project Cost Range: \$24M – \$29M**

**CD – 0 Approve Mission Need - Approval Date, Approving Official and Material Changes**

This Quasi-Poloidal Stellarator Upgrade Project (QPSUP) supports research efforts in the Fusion Energy Sciences (FES) Program to “advance plasma science, fusion science, and fusion technology – the knowledge base needed for an economically and environmentally attractive fusion energy source.” The mission of the QPSUP is to provide unique 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. CD-0 approval of the QPSUP Project was given by N. Anne Davies, Associate Director for Fusion Energy Sciences, on May 14, 2002. There have been no material changes since CD-0 approval.

**1. Desired Outcome and Requirements Definition**

**Summary Project Description**

The heart of the facility upgrade is a set of 20 nonplanar, irregular shaped coils wound on cast, stainless steel coil forms that surround the highly shaped plasma. Additional circular and rectangular coils outside the vacuum tank produce the magnetic field for plasma positioning and shape control, and for driving the plasma current. The coil sets, plus separate control of the nine independent currents in the coil sets, give the configuration flexibility needed for the QPSUP mission. The initial set of plasma control, heating, diagnostic, and power and particle handling systems must also be able to accommodate later upgrades as needed to meet the needs of the research program.

**Performance Parameters Required to Obtain Desired Outcome**

An important goal of the US fusion program, outlined by the Fusion Energy Sciences Advisory Committee (FESAC) in its December 2000 Report of the Integrated Program Planning Activity, is a ten-year goal to “determine the attractiveness of a compact stellarator”. The upgrade will enable the QPSUP as a compact stellarator to explore a new physics regime, using QPSUP configurations at very low plasma aspect ratio with very low damping for poloidal flows that can lead to improved confinement. The QPSUP will allow experiments designed to produce magnetized plasmas with a well-defined set of configuration properties, such as size, shape, magnetic field strength, and pressure, which in turn determine its physics properties. The QPSUP will allow the study of three-dimensional plasma physics issues not accessible in existing facilities. The plasmas to be studied are three-dimensional toroids-doughnut-shaped plasmas whose cross sectional shape varies depending on where in toroidal angle it is sliced. The major performance goals listed in the Preliminary Project Execution Plan are to achieve sufficient magnetic field operation (0.5 - 1 Tesla) and plasma volume ( $2\text{m}^3$ ).

## 2. Cost and Schedule Range

### **Total Project Cost Range**

The QPSUP Alternatives Study dated April 25, 2003, provides detailed information on the cost considerations used for operating and maintaining and is risk adjusted. Fusion experiments like QPSUP typically operate for 10-15 years. The major stellarator core components are expected to have operating lifetimes equal to that of the entire experiment. Therefore, an average of 12 years operating was used for the alternatives analysis. At this stage of the project the annual facility operating and upgrade expenses are estimated at approximately \$7.5M/year, based on previous ORNL experimental devices. The analysis concluded with the preferred option being upgrades at ORNL, which is the least life-cycle cost (LCC), best mitigation of risks and best overall benefit to the Government. The federal integrated project team (IPT) performed detailed analyses for the following three alternatives:

<b>Alternatives</b>	<b>12 Years Operating (M)</b>
New separate facility at ORNL	\$240 – 270M
Upgrade Existing Facility at PPPL	\$129 – 159M
Upgrade Existing Facility at ORNL	\$90 – 119M

**Table 1: Summary Life-Cycle Costs**

At the end of the project's life it is anticipated that the facility will be decommissioned and dismantled with much of the equipment likely to be reused by other projects, as has been done with past fusion experiments. The remaining equipment removal with a negligible amount of radioactive contamination cleanup of the structures should be relatively inexpensive.

The Total Project Cost (TPC) range \$24 – 29M is based on a bottoms-up methodology where the cost for each individual function was estimated using either direct industrial estimates or applicable labor rates and material costs conceptual designs were developed for all systems as the basis for the estimate. Major equipment items are based on vendor quotes for the QPSUP specific items and for similar items to the related National Compact Stellarator Experiment (NCSX) project. The estimate for labor costs for engineering design, procurement, fabrication of the finished coils, device assembly, installation and commissioning are based on the relevant labor rates at ORNL, PPPL and the University of Tennessee (UT)/BWXT. The cost estimate for QPSUP has been refined as a result of incorporating the recommendations of the QPSUP Conceptual Design Report (CDR) report and cost information developed by the NCSX project that are also relevant to QPSUP.

<b>WBS</b>	<b>Cost Element</b>	<b>\$M Low Range</b>	<b>\$M High Range</b>
1	Stellarator Core	9.5	11.0
1.2	Vacuum vessel	.8	1.0
1.3	Coil systems	6.5	7.0
2	Auxiliary Systems	.8	.9
3	Diagnostics	.5	.5
4	Utilities and Power Systems	.5	.5
5	Data Acquisition	.5	.5

6	Core and Facility Integration	.5	.6
7	Project Management and Integration	1.2	2.0
	Total Estimated Cost	20.8	24.0
	Contingency	3.2	5.0
	Total Project Cost	24.0	29.0

**Table 2: Total Project Cost Range**

**Funding Profile**

The funding profile falls within the Program’s out year budget target. There are no anticipated external sources of funding.

	<b>FY05</b>	<b>FY06</b>	<b>FY 07</b>	<b>FY 08</b>	<b>FY 09</b>	<b>Total</b>
<b>Total</b>	<b>\$5M</b>	<b>\$6M</b>	<b>\$11M</b>	<b>\$6M</b>	<b>\$1M</b>	<b>\$29M</b>

**Table 3: Funding Profile**

**Schedule Range and Key Milestones**

The QPSUP is scheduled for completion with the first plasma operation scheduled for January 2009. The major planned schedule milestones are as follows:

<b>Description</b>	<b>Planned FY</b>	<b>Completed/Approved</b>
CD-0 Approve Mission Need	3Q2002	5/14//2001
CD-1 Approve Alternative Selection and Cost Range	3Q2004	
EIR Completed	3Q2005	
CD-2 Approve Performance Baseline	4Q2005	
CD-3 Approve Start of Construction	1Q2007	
Modular Coil Winding Forms Contract Awarded	1Q2007	
Machine Assembly Completed	2Q2008	
CD-4 Approve Start of Operations/Project Closeout	1Q2009	

**Table 4: Major Project Milestones**

**3. Major Applicable Conditions**

**Environmental, Regulatory and Political Sensitivities**

There are no environmental, regulatory or political sensitivities associated with the QPSUP. Regulatory permits for storm water and pollution prevention will be filed with the appropriate agencies prior to the on site/construction modification activities.

**Others**

The initial security requirements for this project have been coordinated with ORNL’s Security Division, and the site office’s technical security personnel. ORNL’s badging will be required to access the construction site with no Q or L clearances required. The project construction area will be isolated into a Controlled Access area during construction.

There are no additional laws, agreements, or other factors to significantly influence this project.

**4. Risk and Alternatives (Technical, Location, & Acquisition Approach)**

*(NOTE: This element should summarize the rigorous evaluation of the possible alternatives across all key risk discriminators. A numerical weighting or ranking approach (high, medium or low) is often very useful as a methodology for documenting the Federal IPT’s process and*

*conclusion. First, summarize the major technical, site location and acquisition alternatives listing the pros and cons for the range of solutions considered. Second, discuss the associated range of risks for the selected alternative. The depth of analysis for each risk category will vary by project type, ranging from not applicable to very extensive. Project planning conducted after CD-0 and prior to CD-1 also requires a description of alternative solutions the IPT considered for accomplishing mission need that the project was expected to satisfy; a description of the results of the feasibility/performance/benefits analysis; and a comparison of the returns (financial and other) for each alternative. This is consistent with OMB A-11, Part 7 that requires the alternative analysis include three viable alternatives, that alternatives be compared consistently, and the alternative chosen must provide benefits and a summary of the reasons for the choice.)*

### **Technical Alternatives Analysis**

The recent report by the Burning Plasma Assessment Committee of the National Research Council emphasized that one of the three main goals of the U.S. fusion program is “to develop fusion science, technology, and plasma confinement innovations as the central theme of the domestic program.” Compact stellarators are a new approach in the world fusion program that offers a route to a more attractive fusion reactor and exploration of new physics regimes. If successful, compact stellarators would lead to steady state fusion reactors of moderate size with good performance that are immune to the harmful plasma-current-driven disruptions of the mainline tokamaks. QPSUP and NCSX complement the existing large world stellarator program by adding the new feature of quasi-symmetry and extending the database to much lower plasma aspect ratio. QPSUP shares some features with the large performance-extension-level Wendelstein 7-X under construction in Germany, but at  $\frac{1}{4}$  the plasma aspect ratio, and builds on the existing stellarator database. NCSX shares some features with tokamaks and builds on the tokamak database. The study in QPSUP of three dimensional plasma physics issues not accessible in existing facilities supports the Office of Fusion Energy Sciences (OFES) program to address these priorities.

An important goal of the U.S. fusion program, outlined by the FESAC in its December 2000 Report of the Integrated Program Planning Activity, is a ten-year goal to “determine the attractiveness of a Compact Stellarator”. The compact stellarator program with NCSX and QPSUP as the new elements was proposed to FESAC as part of its 1999 review of fusion program priorities and balance. The DOE Report of the Integrated Program Planning Activity states that critical scientific issues for the stellarator include the identification of optimal configurations for the magnetic field and the confinement and stability of stellarator plasmas.

### **Location Alternatives Analysis**

The IPT documented their QPSUP Alternatives Study for six location alternatives. The availability of leasing commercial space with major modifications to fit this project outside ORNL was determined as almost nonexistent. If this facility could be sited on private or federal land that could be titled over to a private developer, their third-party capital could be a very attractive option. However, this alternative is not appropriate as this facility is best sited at a location which is already federal land and granting title to the land to a private developer is not practical. Building a privately owned facility on federal land is not financeable. The IPT performed a more detailed evaluation of the top three alternatives at two locations as follows:

1. The existing facility at PPPL requires additional upgrades in the areas of high voltage power systems, utilities, diagnostics and data acquisition to meet QPSUP’s needs, which results in

higher total project costs.

2. The required infrastructure is currently available at Building 7625 at ORNL. It has space for the QPSUP device, offices, control rooms, laboratories needed for the project as well as for assembly, operation and maintenance of QPSUP. The coil and high-voltage power supplies, an auxiliary coil set, and diagnostics from ORNL's earlier Advanced Toroidal Facility (ATF) meet the QPS needs for coil power, configuration flexibility, plasma heating and plasma characterization.
3. The alternative of building a separate dedicated QPSUP facility at ORNL with on-site infrastructure resulted in higher life-cycle costs than modifying current facilities for this small dollar value project which typically would operate only 10-15 years.

Alternative two is recommended. Building 7625 at ORNL is currently equipped with many of the essential integration and infrastructure requirements, security and high current power supplies for the coil systems, high-power plasma heating systems, a demineralized water cooling system, and diagnostics from the ATF project. The key factor in the location recommendation is the cost savings associated with the available, unique infrastructure at the ORNL site relative to that at any other national laboratory or university. The specifics of the cost savings are detailed in the QPSUP Alternatives Study dated April 25, 2003 and summarized in Table 1. The PPPL site was the only other existing site equipped close to the required infrastructure.

#### **Acquisition Alternatives Analysis**

The QPSUP Acquisition Alternatives Study by the IPT considered using various contracting methods. The highly specialized technology and experience required to design, procure, fabricate and assemble a complex research device such as QPSUP is most efficiently obtained for DOE by an ORNL team with PPPL and UT/BWXT, as opposed to direct government acquisition. The combined physics and engineering knowledge base required to successfully accomplish a project of this nature is already in place at ORNL, PPPL and UT/BWXT, whereas DOE would have to assemble and develop a team of at least 50 technical experts to carry out the project. The design, some of the fabrication and the assembly of QPSUP will be largely performed by ORNL staff. PPPL will collaborate in the design and acquisition of some components, with both support and leadership roles. UT/BWXT will provide major support during the modular coil fabrication phase. The majority of the subcontracted work to be performed for QPSUP will be the subject of a multi-stage development program. This development program is similar to that being pursued for NCSX and will yield designs that permit fabrication under fixed-price "build-to-print" subcontracts. For the ancillary systems components, it is anticipated that the majority are readily available off-the-shelf at firm-fixed prices.

The central feature of the QPSUP is the acquisition of the critical components that comprise the stellarator core. The stellarator core includes the modular coils, vacuum vessel, and supplementary coil systems (e.g., toroidal field and poloidal field coils). These major QPSUP acquisitions will be best-value. In order to take advantage of similar acquisitions for the NCSX project, these acquisitions will be the responsibility of PPPL. PPPL will have lead responsibility for quality assurance oversight of the large contracts required to execute this project. PPPL has project management, procurement management and ES&H and QA management systems that are proven to be effective for oversight of acquisitions of this scale and type. While PPPL will oversee procurement of major components, ORNL's research staff is best suited to install the QPS

components. ORNL has management and design responsibility for this project. The largest component of the project is the stellarator core (WBS 1). ORNL is also responsible for WBS 1 for NCSX with an ORNL-PPPL team responsible for the stellarator core sub-elements. UT/BWXT is responsible for the vacuum vessel and in-vessel components.

Additionally, this project is advised by a Project Advisory Committee that reports to the ORNL Fusion Energy Division Director and provides broad-based peer input to the project from the fusion research community. The committee is composed of 12 senior U.S. and foreign fusion scientists from universities and laboratories with broad expertise.

The majority of the components will be “build-to-print” for this major item of equipment upgrade project. As such, a construction type design-build vs. design-bid-build analysis was not performed.

### **Project Risk Analysis:**

The critical risks and mitigation plans identified at the time of the QPSUP Conceptual Design Review are documented in detail in the Preliminary QPSUP Risk Management Plan dated August 2003. This risk listing will be tracked and updated by the QPSUP WBS leaders and project management as a living document to assure that the risk mitigation has adequate management oversight. In addition, the QPSUP WBS leaders and project management will keep a close watch on any changes in risk identification and risk mitigation plans for the NCSX project and will revise the QPSUP Risk Management Plan appropriately.

The estimated costs and contingencies to mitigate these risks are incorporated in the project’s preliminary cost and schedule ranges. The early phases of the QPSUP design process are structured to identify risks. These risks are addressed through design improvements, manufacturing studies, prototypes, schedule and cost range contingencies.

The major QPSUP risks are summarized below:

#### **Cost Range**

Cost risk should remain low based on the benefits of component competition, build-to-print drawings, use of off-the-shelf hardware (when available) and manufacturing and production studies.

#### **Schedule Range**

Schedule risks are considered medium at this early stage of the project mainly for the likelihood of schedule delays for the highly specialized technology and experience required to design, procure, fabricate and assemble a complex research device such as QPSUP in the most efficient manner. These risks will be minimized by best-value acquisitions, and performance-based incentives will be considered if they appear to offer appropriate cost, schedule or technical advantages.

#### **Funding Range and Budget Management**

The probability of disruption due to lack of funding availability is low.

#### **Technology and Engineering**

Risk is medium to high for the highly specialized technology and experience required to design, procure, fabricate and assemble this complex research device. Suppliers from Japan and Europe

have participated in the NCSX manufacturing studies, and it is possible that a foreign supplier could provide a major component for the QPSUP. ORNL has experience in contracting with foreign suppliers. ORNL is also very familiar with requirements for coordination of work and visits by foreign nationals. Lessons learned from other similar projects will mitigate some of the higher risks. Even though a contract may be awarded by PPPL, a specialized technical representative from ORNL or UT/BWXT may be utilized to provide QA oversight. Additionally, the Project Advisory Committee (PAC) will give an overlap with the NCSX PAC and will meet about twice a year to give advice on the development of the QPSUP experimental project.

### **Interfaces and Integration Requirements**

The most critical interfaces will be ongoing site operations with the ORNL M&O contractor. The logistics are being worked out with the M&O contractor in order for the construction site to be isolated for construction activities. This risk is low and is mitigated by the awareness of the ORNL's operations and an agreement to have vehicle and pedestrian flow mapped out prior to construction.

### **Safeguards and Security**

Upgrade of the QPSUP will not require Q or L clearance badges but will require contractors to obtain general DOE ORNL site badging. The project upgrade area will be isolated into a Controlled Access area during construction. Contractors will be required to have a Site-Specific Safeguard and Security Plan. Some schedule risk may occur if a heightened security is directed at ORNL or nationally. Security risk is medium to meet Department of Homeland Security requirements for Federal buildings. Risk of impact to TPC and schedule from this area is low.

### **Location and Site Conditions**

The risk is low for the recommended location and site conditions since it is in an existing FES building where similar projects have been assembled and run.

### **Legal and Regulatory**

There are no legal or regulatory issues at this time. The only major permit required for the upgrade is a storm water permit. The risk to obtain this permit is low.

### **Environmental, Safety and Health (ES&H)**

Safety performance is weighted in the subcontract solicitation evaluation criteria in the RFP. The risk of impact from ES&H concerns is low.

### **Stakeholder Issues**

There are no local community concerns with the proposed upgrade for QPSUP. The risk is low.

### **Conclusion**

Based on the identified risks, life-cycle costs, and anticipated benefits to the Office of Science (SC), the ORNL team is proposed to lead this contractor acquisition team. The ORNL team will manage the inspection of construction upgrade work in progress to ensure compliance with the drawings, required tests, quality to meet acceptance criteria, and all proposed field changes review and approval by the Design Authority. DOE will provide a certified Federal Project Director for the project.

## **5. Business and Acquisition Approach**

### **Acquisition and Contract Types**

The “build-to-print” drawings and commercial items will be placed on a firm-fixed-price basis. It is expected that the drawings are sufficiently detailed to allow prospective small business design and construction firms/teams to formulate firm-fixed-price offers without excessive contingency and allowances.

### **Incentive Approach/Linkage to Performance Metrics**

Most subcontracts will not contain incentives, unless technical or schedule issues arise.

### **Competition**

Based on an initial marketing analysis performed by the IPT, it has been determined that the market can support this acquisition. Similar projects have received substantial competition for the major and commercial components and laid the groundwork for this acquisition. The cost-reduction benefits of competition will be promoted and maintained throughout all phases of acquisition, including the major components. The component that poses the highest degree of manufacturing risk, the modular coil winding form, will be developed through a manufacturing study, procurement of a manufacturing development winding form, and finally a production fabrication subcontract using only the NCSX-qualified vendors. At each step information will be made available to all interested suppliers to the maximum degree possible, and the submission of competitive proposals will be encouraged.

## **6. Management Structure and Approach**

### **Identify IPT, Organization Structure and Staffing Skills**

All Federal IPT members participated in developing this acquisition strategy.

Name	Title	Organization	Phone Number
Gene Nardella	Program Manager	SC Office of Fusion Energy Sciences	301-903-1234
H. Clark	Federal Project Director, IPT Lead, COR	DOE ORNL Site Office	865-576-1234
B. Harness	Contracting Officer	DOE ORNL Site Office	865-576-5678
F. Ward	Security	DOE ORNL Site Office	865-576-2345
J. Wolfe	Capital Budget Advisor	DOE ORNL Site Office	865-576-3456
T. Hornsby	General Counsel	DOE ORNL Site Office	865-576-4567
E. Withers	NEPA Compliance Officer	DOE ORNL Site Office	865-576-6789
E. Trujillo	Building Manager	DOE ORNL Site Office	865-576-7890

**Table 5: Federal IPT**

### **Approach to Performance Evaluation and Validation**

Project performance will be updated monthly in the DOE Project Assessment and Reporting System (PARS) based on progress reporting from the contractor. This project has been in PARS since CD-0 approval. The earned value approach to manage this project will be used and approved by the Federal Project Director. This reporting requirement will be made part of the contract. Project changes will be identified, controlled and managed through a traceable, documented change control process defined in the contract. The QPSUP Federal Project Director with other SC federal technical support staff will monitor the progress of the QPSUP through



surveillance of work, field visits and a variety of monthly status reports and meetings. The SC Construction Management Support Office has performed a Conceptual Design Review and plans to complete independent project cost and schedule validations annually.

**Interdependencies and Interfaces**

It is anticipated that there will be only a few minor pieces of government furnished equipment for the QPSUP contractor. The subcontractors will be required to coordinate with other ORNL subcontractors at the site. In particular, the contractors must obtain safeguards and security support and certain essential services, e.g., utilities and water, from ORNL.

DOE at ORNL has a Site Utilization and Management Plan signed by the Office of Science and other affected Programs dated June 4, 2003, which considers program activities at the site in the context of all programs at the site and is a master strategy for the site’s long term mission in accordance with DOE Acquisition Letter 2000-08 of August 18, 2000.

**Recommendations and Approval**

This document accurately represents the best thinking and efforts of the Project’s IPT to understand the full range of project risks and alternatives available to accomplish the Project scope.

No barriers or impediments to executing this AS, as detailed, exist at this time and the AS is in the best interest of the Department and National Policy.

If new information or facts arise which could have significant impact on the Project’s cost, schedule or performance, we will make the Program Secretarial Officer and OECM aware of this on a timely basis.

The AS may be changed if it makes good business sense to do so. Any changes will be justified and documented. Material changes to the AS such as changes in contract type, competition or major milestones must be documented and approved at the same approval level as the original.

**Recommend Approval:**

---

Federal Project Director	Date	Contracting Officer	Date
--------------------------	------	---------------------	------

**Approval:**

---

DOE Program Secretarial Officer/National Nuclear Security Administration Deputy/Associate Administrator Date

**(NOTE:** *The Program Office Project Management Support Office electronically submits the AS in Microsoft Word to ESAAB.SECRETARIAT@hq.doe.gov at least 3 weeks prior to any scheduled decisional briefings. OECM/for OMBE will provide a recommendation memo to the approving official. Additionally, OECM is available to review draft ASs after the Federal Project Director, Contracting Officer and Program Office Project Management Support Office staff have reviewed the Draft AS.*

*Approval of this AS does not constitute approvals required by DOE HQ Office of Procurement and Assistance Management for specific contract clearance purposes, including contract acquisition plans under Federal Acquisition Regulation Part 7.)*