Acquisition Strategy
for
The Quasi-Poloidal Stellarator

Lead Program Office:

Office of Fusion Energy Sciences
Office of Science

Total Estimated Cost Range: $24 - 29 million

January 2004

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QUASI-POLOIDAL STELLARATOR ACQUISITION STRATEGY

1. Desired Outcome and Requirements Definition

1a. CD – 0 Approval Date, Approving Official and Any Material Changes.

The mission need Critical Decision 0 (CD-0) was approved by N. Anne Davies, Associate Director for Fusion Energy Sciences, DOE Office of Science in May 2001. The mission, physics concept and main configuration features of the Quasi-Poloidal Stellarator (QPS) have not changed since the time of CD-0. There have been changes in the estimated cost and schedule since CD-0 due to a number of factors. In the Department's Office of Fusion Energy Sciences (OFES) program planning, the planned start of the QPS project (start of preliminary design) was delayed from October 2003 to October 2004 and the projected start of operation from September 2007 to January 2009. The estimated cost has risen due to a number of factors: design improvements that reduce risks, input from manufacturers on major component costs, recommendations from the CDR panel, addition of a program of flux surface mapping and plasma heating in the project, additional schedule contingency, and escalation. The project has made use of cost information developed by the National Compact Stellarator Experiment (NCSX) project, which is being built at the Princeton Plasma Physics Laboratory (PPPL), to improve its estimates. The combination of these factors has led to an increase in the cost of the QPS MIE project from the CD-0 estimate of $14.9 million to a post-CDR estimate of $24.3 million.

1b. Summary Project Description and Scope.

The mission of the U.S. Fusion Energy Sciences Program within the DOE Office of Science is to "advance plasma science, fusion science, and fusion technology–the knowledge base needed for an economically and environmentally attractive fusion energy source."

The recent report by the Burning Plasma Assessment Committee of the National Research Council (NRC) emphasized that one of the three main goals of the US fusion program is "to develop fusion science, technology, and *plasma confinement innovations* as the central theme of the domestic program."

The concept-exploration-level Quasi-Poloidal Stellarator (QPS) is an integral part of the Department's OFES program and provides a unique opportunity to advance its mission. The mission of the QPS 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. The QPS will explore a new physics regime, using quasi-poloidal stellarator configurations at very low aspect ratio with very low damping for poloidal flows that can lead to improved confinement. In this regard it complements the larger quasi-axisymmetric proof-of-principle NCSX, the largest element in the Compact Stellarator 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. QPS and NCSX complement the existing large world stellarator program by adding the new feature of quasi-symmetry and extending the data base to much lower plasma aspect ratio. QPS shares some features with the large performance-extension-level Wendelstein 7-X under construction in Germany, but at 1/4 the plasma aspect ratio, and builds on the Wendelstein database. NCSX shares some features with tokamaks and builds on the tokamak database.

An important goal of the US fusion program, outlined by the Fusion Energy Sciences Advisory Committee (FESAC) in its December 2000 Report on Integrated Program Planning Activity, is a ten-year goal to "determine the attractiveness of a Compact Stellarator". The compact stellarator program with NCSX and QPS 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.

The recent report by NRC's Burning Plasma Assessment Committee additionally states:
"Research in innovative and alternate magnetic fusion concepts is contributing to an understanding of how to design, implement and control future fusion devices." and
"The fusion research portfolio addresses issues of importance to developing the knowledge base for fusion energy. It involves studies of plasma properties across a range of different magnetic configurations to test basic understanding of magnetically-confined plasmas, improve reactor concepts, and establish the science base which underlies the large-tokamak and burning plasma experimental programs." The study, in QPS, of three-dimensional plasma physics issues not accessible in existing facilities, supports the OFES program to address these priorities.

1c. Performance Parameters Required to Obtain Desired Outcome.

Key technical and performance parameters. The QPS experiment is 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 QPS will provide the flexibility to vary the configuration parameters over a wide range. 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 magnetic field coils, which control the plasma shape, must be constructed to precise shape specifications. The QPS will provide an initial set of plasma control, heating, diagnostic, and power and particle handling systems and will be able to accommodate later upgrades as needed to meet the needs of the research program. The threshold performance requirements are sufficient magnetic field (0.5 T), plasma volume (2 m^3), and configuration flexibility to initiate the QPS mission. The full design objectives only assume higher-field (1 T) operation. The QPS design and the infrastructure available at ORNL satisfy these requirements.

The heart of the facility is a set of 20 nonplanar, irregular shaped coils wound on cast, stainless steel coil forms that surround the highly shaped plasma. The coils are mounted inside a cylindrical vacuum tank that produces a high-vacuum plasma environment with access for heating, pumping, diagnostics, and maintenance. Additional circular and rectangular coils outside the vacuum tank produce the magnetic field for plasma positioning and shape control, and for driving a plasma current. These coils sets, plus separate control of the nine independent currents in the coil sets, give the configuration flexibility needed for the QPS mission. Figure 1c-1 shows a cutaway view of the QPS device.

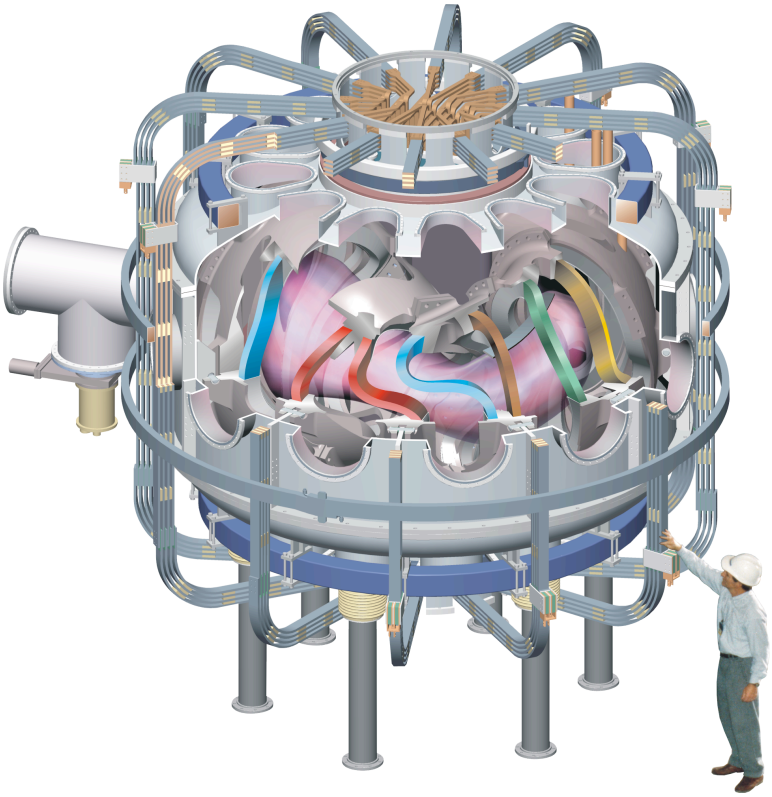

Figure 1c-1. The QPS Device.

Location. The QPS project requires considerable infrastructure, facilities, and resources. The required infrastructure is uniquely available at the proposed site for QPS at ORNL. The new multi-purpose building 7625 at ORNL has the required features. It will have the space for the QPS device and offices, control room, laboratories, etc. needed for the project as well as for assembly, operation, and maintenance of QPS. The coil and high-voltage power supplies, an auxiliary coil set, and some diagnostics from ORNL's earlier Advanced Toroidal Facility meet the QPS needs for coil power, configuration flexibility, plasma heating, and plasma characterization. Use of the ORNL site takes advantage of the lab's decades of experience in designing and operating fusion experiments like QPS. This long history of fusion experience has produced a knowledgeable organization, procedures, and the human resources well suited to carry out the QPS Project. The key factor in the site decision is the cost saving associated with the available, unique infrastructure at the ORNL site relative to that at any other national laboratory or

university. While other sites may have some of the required infrastructure, the ORNL fusion infrastructure is very closely matched to the needs of the QPS project, and therefore the cost savings are the greatest at the ORNL site.

2. Cost and Schedule Range

2a. Total Project Cost (TPC) Range.

The preliminary Total Estimated Cost (TEC) is $24.3M, which includes the estimated costs for the design, manufacturing development, fabrication, assembly, installation and 27% overall contingency (the contingency on the most difficult components is 36%). Unless otherwise noted, all costs are in year-of-expenditure dollars assuming an October 2004 start of project. The starting point for the estimate is the QPS Conceptual Design Report (CDR), which was reviewed by the Office of Science in June 2003. This estimate relied 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 (including fees, expenses, applicable overheads, taxes, and escalation). Conceptual and/or preliminary performance specifications and drawings were developed for all systems as the basis for the estimate. Major equipment items are based on a combination of actual vendor quotes for the QPS-specific items and vendor quotes for similar items in the related 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). The cost estimate for QPS has been refined as a result of incorporating the recommendations of the QPS CDR report and cost information developed by the NCSX project that are also relevant to QPS. Since QPS is designated as a major item of equipment (MIE) funded entirely by capital equipment funds, there are no other project costs and the term TPC does not apply. The project will use an appropriate form of price or cost analysis to compare each procurement with the TEC estimates for validation. In this way the TEC will serve as the "should-cost" benchmark as the project evolves.

The QPS MIE project has a preliminary TEC range of $24–$29 million. The upper value represents an additional 19% contingency above the preliminary TEC. The major cost elements making up the estimate are listed in the Table 2a-1 by Work Breakdown Structure (WBS) elements.

Table 2a-1. QPS WBS Cost Elements

WBS	Cost Element	$k
1	**Stellarator Core**	**13006**
12	Vacuum vessel	1085
13	Conventional coil systems	1228
14	Modular coil systems	8832
15	Coil structures	416
16	Coil services	422
17	Base structures	104
18	Core assembly	919
2	**Auxiliary Systems**	**904**
3	**Diagnostics**	**474**
4	**Power Systems**	**457**
5	**Central I&C and Data Acquisition**	**490**
6	**Utilities**	**85**
7	**Core and Facility Integration**	**805**
8	**Project Management and Integration**	**2978**
	Project Estimate	**19198**
	Contingency (27% average)	**5095**
	Total, with contingency, as spent	**24293**

Although the total life-cycle cost has yet to be determined because it depends on the duration of the experimental program and the equipment upgrades that are implemented, it is possible to identify the cost components. Fusion experiments like QPS typically operate for about 10 years or more, and the major stellarator core components are expected to have operating lifetimes equal to that of the entire experiment. As is typical of fusion experiments, it is anticipated that additional upgrades to enhance the performance will be acquired during the project's lifetime. At this stage of the project the annual facility operating and upgrade expenses are estimated at approximately $7.5M/year, similar to that for the University of Wisconsin Madison Symmetric Torus, a facility comparable to QPS in size and scope. A more definitive estimate will be developed for the CD-2 milestone.

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 re-used by other projects, as has been done with past fusion experiments at ORNL. The remaining equipment would be removed and it is expected that these activities would be routine and relatively inexpensive. An estimate will be developed for the CD-2 milestone. A negligible amount of radioactive activation and/or contamination of the structures is expected, as is typical for small fusion experiments of the scale of QPS.

2b. Funding Profile.

Similar to other Office of Science MIE projects, the QPS MIE budget consists of what is spent on QPS MIE fabrication project each year and the additional B/A needed each year for commitments for the next year, which sums to zero over the project. Research Preparation funding is needed in addition to prepare for QPS operation and includes, for example, funding for diagnostic preparation, development of analysis programs, and additional plasma heating that is needed for the early stages of the research program. The preliminary QPS funding profile shown in Table 2b-1 is based on discussions with OFES and incorporating the CDR recommendations. The QPS MIE project will be entirely funded by OFES; there are no inter-agency funding agreements or external sources of funding.

Table 2b-1. Proposed QPS Funding Profile

	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	Total
Total B/A needed for MIE project	$5.01M	$6.30M	$6.25M	$5.72M	$1.01M	$24.29M

2c. Key Milestones and Events.

The QPS Project is scheduled for completion (first plasma operation) in January 2009. A preliminary schedule of key milestones for the QPS Project is listed in Table 2c-1.

Table 2c-1. Preliminary Milestones and Schedule for the QPS Project

Milestone	Schedule
DOE CD-1 (Alternative Selection & Cost Range) Approval	March 2004
EIR/DOE PDR Completed	April 2005
DOE CD-2 (Performance Baseline) Approval	July 2005
DOE CD-3 (Start Construction) Approval	November 2005
Modular Coil Winding Forms Contract Awarded	December 2005
Machine Assembly Completed	August 2008
Operational Readiness Assessment Completed	December 2008
DOE CD-4 (Start Initial Operations) Approval	January 2009

3. Major Applicable Conditions

3a. Environmental, Regulatory and Political Sensitivities.

There are no environmental, regulatory or political sensitivities associated with the QPS project.

3b. Others.

There are no considerations known at this time that would affect the QPS project. There are no special priorities, allocations, or allotments requirements associated with procuring components for the QPS Project. At this time there are no known intellectual property licensing issues associated with the QPS Project.

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

The critical risks and mitigation plans identified at the time of the QPS Conceptual Design Review are documented in detail in the QPS Risk Management Plan (ORNL/CF-03/31), which is with the other CD-1 documentation on the QPS web site (http://www.iqps.fed.ornl.gov) and will be made available on request. The estimated costs and contingencies to mitigate these risks are incorporated in the project's preliminary cost and schedule estimates.

The early phases of the QPS project design process are structured to identify risks. These risks are addressed through design improvements, manufacturing studies, prototypes, schedule contingency, and cost contingency. The budget contingency methodology is outlined in the Preliminary Project Execution Plan and is the same as used for the NCSX project. In many cases the risk mitigation comprises several of the mitigation elements listed above. This risk listing will be tracked and updated by the QPS WBS leaders and project management as a living document so as to avoid overlooking important risks and to assure that the risk mitigation has adequate management oversight. In addition, the QPS 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 QPS Risk Management Plan appropriately.

The responsibility for risk management rests with the QPS line management. The QPS WBS leaders and project management identify risk areas, develops risk mitigation plans, and monitors performance against those plans. The design engineers, with the appropriate management oversight, establish the specific approaches to addressing the individual risk elements. An important asset in identifying and mitigating risks is the QPS Team's close connection with the NCSX project, which has engineering design and fabrication features in common with QPS. ORNL is a partner in the NCSX project and responsible for the design of the stellarator core. The principal members of the QPS Team are on the NCSX System Integration Team and are involved in identifying risks in the NCSX project and the plans to mitigate them. NCSX precedes QPS in the approval, design, R&D, and fabrication phases by 1–2 years, which allows time for the experience gained in the NCSX project to be factored into the QPS project.

4a. Cost and Schedule Range.

Cost overruns and schedule delays can occur due to a wide range of causes. Mitigation of these risks involves system engineering, manufacturing development, competition, maintaining ample budget contingency, and establish minimum performance and scope thresholds as described in the QPS Risk Management Plan.

The main cost and schedule risks are associated with the manufacturing of the modular coils with unique shapes and precise tolerance requirements. To mitigate these risks, a manufacturing study will be done for the coil winding forms and an R&D coil will be fabricated including procurement of the most difficult cast winding form, machining to the required tolerance, winding the actual copper conductor on the form, welding a stainless steel cover, and vacuum pressure impregnation of the coil. The project will use one or more of the vendors being qualified in the NCSX project or by the large Wendelstein 7-X project, which is a large stellarator currently under construction in Germany. To further mitigate cost and schedule risks, the QPS project will continue to take advantage of knowledge developed by the related NCSX project for relevance to QPS and conduct periodic design reviews as the design evolves, pursue additional manufacturing development activities if needed, and implement a phased procurement strategy.

4b. Funding Range and Budget Management.

Table 2b-1 (above) gives the proposed Budget Authority (BA) funding profiles for both the QPS MIE Project TEC and the separate category of QPS Research Preparations and Facility Operations. These profiles reflect current project planning that incorporates recommendations from the recent Conceptual Design Review. Both of these profiles are provided for completeness. The parallel research preparation activity, funded separately from the MIE project, will be carried out during the QPS project period (FY2005-FY2009). This activity includes funds in FYs 2007-2009 for the preparation of the diagnostics, analytical tools, and heating systems that will be needed for the early phases of the research program. These tasks will maintain an active physics component of the QPS program during machine fabrication. This is very similar to the approach that is being followed for NCSX as well as other fusion devices that have been built.

4c. Technology and Engineering.

The adoption of a simple, robust machine design concept ensures that the design can be readily developed to meet all requirements. This mitigates the risk of cost growth or schedule delays that would occur if the concept had to be changed, or program impacts if major performance sacrifices had to be made. There is no new technology to develop for this concept, so no development other than the manufacturing and fabrication processes being developed for the NCSX project are required.

The modular coil winding forms are the highest risk components. During the NCSX conceptual design, manufacturing studies by industrial participants were conducted for NCSX to obtain feedback on planned manufacturing processes, input on feasibility issues and technical risks, and suggested manufacturing development activities to mitigate risks. In many instances, the studies carried out by the NCSX project are directly relevant to

QPS and the results of these efforts will be incorporated into the QPS project. The QPS Project will also use the results of the NCSX manufacturing development activities for the design and manufacturing of the modular coil forms. This NCSX activity is ongoing and will be used as a component in the QPS selection of vendor or vendors to fabricate the production units.

4d. Interfaces and Integration Requirements.

No significant risks have been identified with regard to interfaces and integration. The project will receive program guidance and funding from OFES. The Director of OFES will serve as the QPS MIE project's Acquisition Executive. A Federal Project Director at the DOE Oak Ridge Operations Office will carry out implementation and project management. ORNL has assigned a QPS Project Manager who will manage the project. The project has been integrated with NCSX activities and site activities at ORNL through the establishment of an Integrated Project Team that includes members from the QPS team, NCSX, and OFES (see section 6). The QPS team interfaces with UT through the UT Principal Investigator, Dr. Thomas Shannon. The management arrangements for winding, vacuum canning, and potting the QPS modular coils at UT are described in a separate document (UT_winding_plan.doc).

4e. Safeguards and Security.

Normal ORNL security requirements will be applied to QPS design and installation activity. QPS project activities will create no new security issues during design and installation. No laboratory safeguards and security requirements will need to be changed for operations. The facility is expected to be a low-hazard, non-nuclear facility. Normal site access security requirements will exist for QPS activity in accordance with ORNL site security procedures. Access to and from the job site will be controlled by ORNL security forces, and the ORNL Contractor/Vendor management system which includes minimum training requirements, card reader access systems, and a contractor database to monitor contractor egress and debarment status. None of the work on the QPS is classified and a system is in place for accommodating foreign research scientists.

4f. Location and Site Conditions.

There are no known risks associated with the location or site conditions. The QPS will be located at ORNL to maximize the use of existing fusion energy program infrastructure, facilities, and resources. A new multi-purpose building that meets all the QPS project specifications is being built at the ORNL site under GPP funds and will be completed by October 2004. Additionally, at the QPS site, there are high-current power supplies for the coil systems, high-power plasma heating systems, and a demineralized water cooling system. In addition ORNL has an exceptionally strong stellarator theory program, which has produced the principal tools used throughout the world for design and analysis of stellarators, an exceptionally strong engineering group, which is responsible for the design of the stellarator core systems for NCSX, and an experimental team with experience on both stellarators and tokamaks. Use of the ORNL site takes advantage of the ORNL's decades of experience in designing and operating fusion

experiments like QPS, which has produced a knowledgeable organization, procedures, and the human resources well suited to carry out the QPS Project.

The key factor in the site decision is the cost saving associated with the available, unique infrastructure at the ORNL site relative to that at any other national laboratory or university. While other sites may have some of the infrastructure needed, the ORNL fusion infrastructure is very closely matched to the needs of the QPS project, and therefore, the risks are least and the cost saving is greatest at the ORNL site.

4g. Legal and Regulatory.

The QPS project will have no difficulty in fully complying with all applicable Federal, state and local requirements. The QPS is an MIE fabrication project and not a construction project, so it does not require construction permits. There are no known legal or regulatory issues that could impact the project.

4h. Environmental, Safety and Health (ES&H).

All work done on QPS will be in accordance with applicable Federal, state and local guidelines for environmental objectives. There are no significant ES&H risks for the QPS project, as documented in the National Environmental Policy Act (NEPA) Action Review and Documentation form that has been approved by DOE. The QPS facility is covered by the approved Categorical Exclusion (CX) *Analytical Services and Development Support Activities* (3014X) at Number 7 (Fabricating, installing, modifying, repairing, and/or relocating laboratory-scale equipment used in performance of sample analysis and research and development projects). In addition, the QPS research activities are covered by the CX for *Research and Development Activities Conducted by ORNL Fusion Energy Division* (2927X). The existing Integrated Safety Management (ISM) Program in place at ORNL will be applied in the design and fabrication of QPS. QPS Project management is responsible for the safe execution of the QPS Project.

4i. Stakeholder Issues.

There are no significant stakeholder issues anticipated. The QPS project is included in the ORNL Institutional Plan. UT is a partner in fabrication of the modular coils for QPS and discussions have been held with the ORNL-UT Leadership Committee. PPPL is the main collaborator on QPS and responsible for design of some of the auxiliary QPS coils and is represented on the QPS Integrated Project Team. Other universities and foreign laboratories that may collaborate in the QPS experimental program have shown strong support for the QPS project. ORNL will continue to include stakeholders in QPS discussions through annual meetings of the QPS Project Advisory Committee, presentations at national and international scientific meetings, and as the experimental program nears, a Program Advisory Committee that will be formed with representation from the institutions collaborating on QPS and senior U.S. and foreign fusion scientists. The QPS program will have a positive impact on ORNL's ability in the fusion area to train new researchers and support university collaboration programs, especially in the Southeast, and thesis students, as it has in the past. QPS is also important for strengthening the theory and plasma technology components of the ORNL program.

5. Business and Acquisition Approach

5 a. Acquisition and Contract Types.

The design, some of the fabrication, and the assembly of QPS will be largely performed by ORNL staff. PPPL will collaborate in the design and procurement of some components, with both support and leadership roles. UT will provide major support during the modular coil fabrication phase. The majority of the subcontracted work to be performed for QPS consists of hardware fabrication. The major stellarator components to be specially fabricated for QPS 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. For standard, build-to-print fabrications and the purchase of off-the-shelf equipment for routine applications, available purchasing techniques include price competition among technically qualified suppliers and use of competitively awarded blanket purchase agreements.

The QPS General Requirements Document, the Preliminary Project Execution Plan, and the Conceptual Design Report (without cost estimates) will be provided to potential bidders via access to the QPS Manufacturing web page at http://www.qps.fed.ornl.gov to ensure an understanding of the requirements for the QPS Project.

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 QPS device. In case this occurs, ORNL has experience in contracting with foreign suppliers. ORNL is also very familiar with the requirements for coordination of work and visits by foreign nationals.

The possibility of direct DOE procurement of the QPS facility was also assessed. The highly specialized technology and experience required to design, procure, fabricate, and assemble a complex research device such as QPS is most efficiently obtained for DOE by ORNL as opposed to direct government procurement. The combined physics and engineering knowledge base required to successfully accomplish a project of this nature is already in place at ORNL and PPPL, whereas DOE would have to assemble and develop a team of experts to carry out the project.

5b. Incentive Approach/Linkage to Performance Metrics.

Depending on schedule considerations, it may be appropriate to use one or more fixed-price subcontracts with incentives based on negotiated delivery or cost targets. These performance-based incentives will be considered by the Project if they appear to offer appropriate cost, schedule, or technical advantages.

For lower dollar value procurements that have some technical or administrative complexity, the ORNL purchasing system provides a tailored approach to the implementation of best value procurement techniques. The core requirement of these less-formal methods is the development of a clear, coherent set of evaluation factors that are consistently applied to all proposals.

5c. Competition.

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 one of 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. Off-the-shelf hardware will be purchased through the ORNL procurement system, using a variety of appropriate, competitively-awarded purchasing vehicles, including subcontracts, purchase orders and blanket purchase agreements.

The QPS Project intends to use firm fixed-price contracts for all production components. In order for this to be feasible, it may be necessary to use cost-reimbursement contracts for development items such as the modular coil winding form manufacturing studies and the prototype winding form casting(s). For conventional components such as the vacuum vessel and conventional coil sets, a fixed price contract without the need for supplemental development work is planned.

The project acquisition philosophy is to encourage full competition to the maximum extent feasible. Should sole source requirements be identified during the course of the project, these will be documented on a case-by-case basis in accordance with approved procurement procedures.

The central feature of the QPS acquisition strategy and planning is the procurement 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). In order to take advantage of similar procurements for the NCSX project, the major procurements for QPS will be the responsibility of PPPL. This approach will be used for the modular coil winding forms, the vacuum vessel, the center stack, and the toroidal field coils. The PPPL purchasing system provides a variety of source selection procedures geared to the cost and technical complexity of the product to be purchased. The major QPS procurements will be best-value procurements. For each such procurement, a subcontract procurement evaluation board (SPEB) will be appointed. The SPEB will typically include both ORNL and PPPL members and will be appointed by the PPPL source selection official (SSO) with the concurrence of the ORNL Fusion Energy Division Director. The SPEB is responsible for: developing a source selection plan for best-value procurement that meets the QPS requirements, developing the solicitation package including evaluation criteria, evaluating all proposals received, and preparing a report documenting its evaluation and recommendation to the PPPL SSO, who makes the ultimate selection decision with the concurrence of the ORNL Fusion Energy Division Director. Once the selection is made, the SPEB members work with the Procurement representative to debrief unsuccessful bidders. For the remaining components, it is anticipated that simple build-to-print, fixed price procurements based on firm specifications are feasible.

PPPL will have lead responsibility for oversight of the large contracts required to execute this project. The technical representative on a contract may be an ORNL or a PPPL

person, but QA oversight will be performed by PPPL. PPPL has project management, procurement management, and ES&H and QA management systems that are proven to be effective for oversight of procurements 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.

6. Management Structure and Approach

6a. Identify IPT, Organization Structure and Staffing Skills.

The QPS project is led by ORNL with support from PPPL and the University of Tennessee (UT). The project organization is established within ORNL and reports to DOE through the Fusion Energy Division Director. ORNL has management and design responsibility for the project.

The contractor project organization has been in place and functioning well since 1998 in managing the QPS project through the physics definition, pre-conceptual design, and conceptual design phases. The project is supported in the areas of quality assurance; environment, safety, and health (ES&H); and procurement by the respective ORNL organizations.

The project organization chart appears in Figure 6a-1. The largest component of the project (~75%) 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. The WBS managers for the stellarator core components are basically the same for both projects. Responsibilities for the sub-elements under this WBS for QPS are

WBS 1 Stellarator Core Systems: B. Nelson (ORNL)
WBS 11, 12 Vacuum Vessel and In-Vessel Components: P. Goranson (BWXT)
WBS 13 Conventional Coils (includes TF, PF, and center stack integration):
P. Heitzenroeder (PPPL)
WBS 14 Modular Coils (includes winding, vacuum canning and VPI):
D. Williamson (ORNL)
WBS 15 Coil Supports: T. Brown (PPPL)
WBS 16 Coil Services: M. Cole (ORNL)
WBS 17 Base Structure: M. Cole (ORNL)
WBS 18 Stellarator Core Assembly: M. Cole (ORNL)

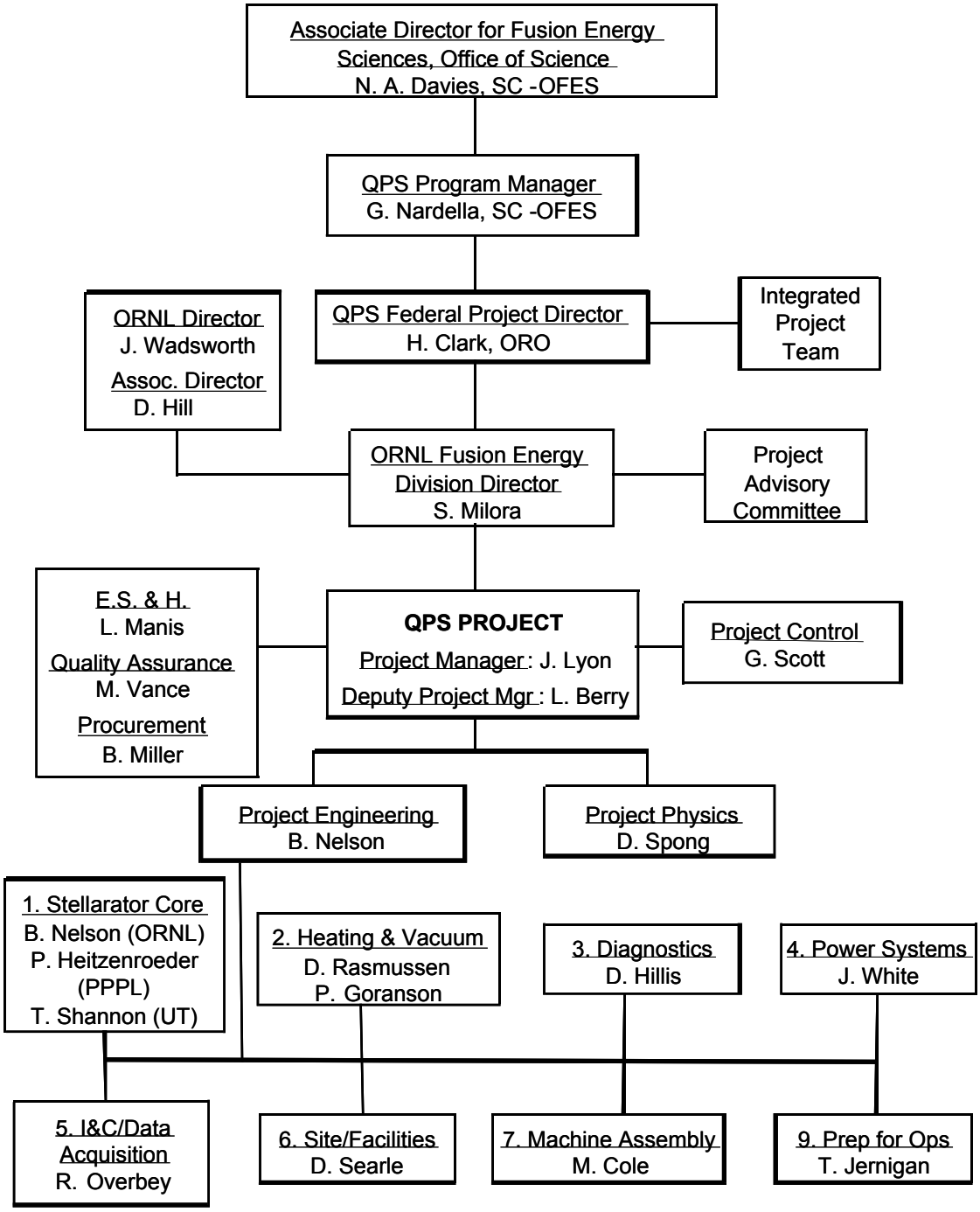

Figure 6a-1. QPS Project Organization

The project is advised by a Project Advisory Committee (PAC) that reports to the ORNL Fusion Energy Division Director and provides broad-based input to the project from the fusion research community. The committee is composed of senior U.S. and foreign fusion scientists with broad expertise. Its members are

D. Anderson, U. Wisconsin
B. Blackwell, Australian National Univ.
S. Kaye, Princeton Plasma Physics Laboratory
S. Knowlton, Auburn Univ.
H. Kugel, Princeton Plasma Physics Laboratory
S. Luckhardt, Univ. of California at San Diego
G. H. Neilson, Princeton Plasma Physics Laboratory
S. Okamura, National Institute for Fusion Science, Toki, Japan
W. Reiersen, Princeton Plasma Physics Laboratory
A. Weller, Max Planck Institute for Plasma Physics, Greifswald, Germany
M. Zarnstorff, Princeton Plasma Physics Laboratory
H. Weitzner, New York University, Chair

The membership was selected to give an overlap with the NCSX PAC and to have knowledgeable NCSX team members from PPPL to ensure that the committee would be knowledgeable about compact stellarator issues and to have better interaction between the NCSX and QPS projects. The PAC met in Dec. 2002 and will meet about once a year, as the project proceeds. As the experimental program nears, a Program Advisory Committee will be formed with representation from the institutions collaborating on QPS and senior U.S. and foreign fusion scientists. This committee would meet about twice a year to give advice on the development of the QPS experimental program.

<u>QPS Integrated Project Team (IPT)</u>.

The IPT holds teleconference meetings approximately monthly, plans the major project reviews, and guides preparation of documentation for all critical decisions. All members of the team participated in the development of this Acquisition Strategy. Consistent with DOE Order 413.3 and DOE Manual 413.3-1, there is an appropriate mix of skills among the team members to successfully execute the QPS MIE project. The members of the IPT and their roles and responsibilities are described below.

Harold Clark (DOE-Oak Ridge Office) is the DOE QPS Federal Project Director and chair of the QPS IPT.
Gene Nardella (DOE-Office of Fusion Energy Sciences) is the QPS Program Manager and the NCSX Program Manager for OFES.
Jim Lyon is the ORNL QPS project manager and deputy project manager for NCSX.
Lee Berry (ORNL) is the QPS deputy project manager.
Brad Nelson is the ORNL QPS engineering design manger and responsible for design of the NCSX stellarator.
Hutch Neilson (PPPL) is the NCSX project manager and the PPPL project lead for QPS.

6b. Approach to Performance Evaluation and Validation (i.e., Earned Value Management System).

Surveillance of the QPS work will be done at two basic levels:

First, the Federal Project Director will monitor and evaluate ORNL project performance against technical, cost, and schedule baselines through monthly project reports, quarterly project performance reviews, and in-depth reviews. ES&H and QA performance will also be monitored.

Second, ORNL has overall project management responsibility, including accomplishing the work, monitoring, through PPPL, all subcontractors, and assuring ES&H and QA performance. For earned value management, ORNL intends to use Primavera and Microsoft Project and work with PPPL to ensure that equivalent procedures are used for both the NCSX and QPS projects. The project will establish a project performance and an Earned Value Management System that is compliant with the ANSI/EIA-748 standard and will report the project status and performance in the DOE Project Analysis and Reporting System. Value engineering as a process has been a continuing part of the QPS conceptual design. That process has been formalized with the initiation of preliminary design, and the results will be submitted as part of the preliminary design review.

6c. Interdependencies and Interfaces.

The QPS project is consistent with the ORNL scientific mission and the facility is included in ORNL's Institutional Plan and Strategic Facilities Plan. As discussed in Section 4.i, ORNL will continue to include stakeholders (DOE, UT, PPPL and collaborating universities and foreign laboratories) in QPS discussions through monthly meetings of the QPS Integrated Project Team, annual meetings of the QPS Project Advisory Committee, presentations at national and international scientific meetings, and as the experimental program nears, a Program Advisory Committee that will be formed with representation from the institutions collaborating on QPS and senior U.S. and foreign fusion scientists.