QPS CDR Disposition Status

September 8, 2003

Updated January 12, 2004

I. Items that Require Action before CD-1 Submission

Item	CDR Panel Recommendation	QPS Team Response
	Action Items	
1	Reach agreement on the funding profile with the DOE Fusion Energy Sciences Program Office, prior to CD-1	**Completed**. Jim Lyon worked with Gene Nardella (OFES) to develop a supportable funding profile for the QPS MIE project. The proposed funding profile has $5.01M in FY-2005, $6.30M in FY-2006, $6.25M in FY-2007, $5.72M in FY-2008, and $1.01M in FY 2009. It is documented in the QPS Acquisition Strategy document and the QPS Preliminary Project Execution Plan. The final funding profile will depend on the FY 2005 budget.
2	Develop the preliminary management plan for the coil winding activity at the University of Tennessee, by CD-1. Key issues that must be addressed include staffing, training, supervision (including ORNL oversight), quality assurance, safety, and responsibility for cost, schedule, and technical performance.	**Completed**. A plan has been developed by the QPS Team and iterated with the Principal Investigator at UT (Tom Shannon). The plan was sent to OFES for comment in Sept. 2003. The 6-page plan covers: general organization, contractual arrangement, and responsibilities for cost, schedule, and technical performance; winding team personnel and supervision / oversight; facilities, tooling, fixtures, and special equipment; R&D and training of team members; QA, QC, and risk mitigation; safety considerations; work planning, work authorization, and performance reporting; and cost and schedule accounting. In addition, we explored options to wind the coils at PPPL or ORNL. All three options were costed and the most attractive option that meets our needs is winding the coils at UT.

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	2.2. Engineering	
2.2-3	Prior to CD-1, complete the development of the technical requirements (GRD) and the management plans that will govern how the QPS project will be run. The plans should: (1) Address the requirements of the new DOE M 413.3-1, Project Management for the Management of Capital Assets. (2) Treat QPS as a $20 million project in terms of project reporting and management systems; and (3) Address design development (design reviews and specifications), change control, earned value reporting, work planning and authorization, and integration of other key participants.	**Completed**. Both the General Requirements Document (GRD) and the management plans governing how the QPS project is run were completed as part of the CD-1 document preparation. The management plans address the requirements in DOE M 413.3 and the other items listed in this recommendation.
	2.5. Power Systems, Site, and Utilities	
Item	**CDR Panel Recommendation**	**QPS Team Response**
2.5-2	Evaluate total lift weight of the modular coil assembly including potential design growth, as well as weight of lifting fixtures to ensure that planned crane capacity is compatible prior to finalizing building design requirements.	**Completed.** The crane capacity is fixed at 20 tons. The lifting fixture consists of cables and does not add significantly to the modular coil assembly weight of 17 tons. We will continue to monitor the design weight of the modular coil assembly and modify it if needed to ensure that it is compatible with the crane capacity.
	2.6. Assembly and Commissioning	
2.6-3	Examine the coil and coil module assembly schedule to increase slack time and reduce schedule slippage risk, prior to CD-1.	**Completed**. We revised the coil and coil module assembly schedule in consultation with PPPL to ensure that adequate time is built into the QPS schedule. There is now five months contingency in the QPS schedule.

Item	CDR Panel Recommendation	QPS Team Response
	3.1. Cost	
3.1-1	Perform a comparative cost estimate of common elements of QPS vs NSTX to confirm reasonableness of $19.95 million estimate, prior to CD-1.	**Completed**. We have obtained some cost data for NSTX components to see if it is possible to compare with a comparable component on QPS. The differences between NSTX and QPS make such an assessment not useful. However, the cost assumptions for the related NCSX have been used. The QPS cost estimate has risen to $24.3M as a result of delaying project completion from September 2007 to January 2009, design improvements that reduced risks, input from manufacturers on major component costs, the panel recommendations, addition of a program of flux surface mapping and plasma heating in the project, additional schedule contingency, and escalation.
3.1-2	Ensure that all project related costs, including Integrated Safety Management, ES&H costs, Quality Management and DOE reviews, etc., are priced into the current estimates, prior to CD-1.	**Completed**. All project related costs, including these items, have been priced into the current estimates.
3.1-3	Develop a cost and schedule estimate "range" prior to CD-1 that reflects uncertainty for the current level of project development, prior to CD-1.	**Completed**. A cost estimate range of 20%, the same as used for NCSX, has been used. The cost estimate range is $24-29 million. The schedule range has been revised to accommodate recommendation 2.6-3 and the budget guidance from DOE in response to action item #1.
	4. Management	
4-1	Initiate PARS reporting for the QPS project. This includes early implementation of Earned Value Management System tracking and reporting at CD-2.	**Completed**. PARS reporting for the QPS project has been implemented by Harold Clark (ORO). Earned Value Management System tracking will be implemented as soon as possible and reported at CD-2.
4-5	Develop a risk management plan, prior to CD-2.	**Completed**. According to DOE M 413.1, this plan is actually needed for CD-1 and has been developed for the CD-1 documentation.

II. Actions Required or Are Useful before CD-2 Submission (by the end of 2004)

Item	CDR Panel Recommendation	QPS Team Response
	2.1. Physics	
2.1-1	Explore the consequences of magnetic field errors in coil fabrication and misalignment. Determine the widths of induced islands, if any.	**In progress**. Don Spong has written a code to calculate e-beam orbits for a given coil (distortion) and currents and Dennis Strickler has incorporated his field-line following code in the STELLOPT code to measure (and minimize) island widths in vacuum. We will also run some PIES cases to check the results at finite beta.
2.1-2	Justify the assumed tolerances for errors in magnetic coils fabrication.	**In progress**. The answers obtained from 2.1-1 and from the NCSX studies will be used to specify the tolerances and their distribution around the coils for fabrication of the modular coils.
2.1-6	Re-order the scheduling of the experimental program to permit exciting physics studies earlier in the program.	**Partially completed**. We have already decided to use ECH for first plasma instead of Ohmic heating to allow a faster start of the experimental program and added flux surface mapping and measurement of deviations from quasi-poloidal symmetry as part of the MIE project. Further optimization of the experimental program order will be done as part of the separately funded Research Preparation activities. We will examine the possibility of rearranging the ECH staging (existing 53 GHz and 28 GHz) and initial diagnostics to allow earlier studies of: (1) energetic electron confinement, (2) poloidal flows, (3) fluctuations, (4) flux surface robustness and magnetic islands, (5) scaling with magnetic field, and (6) an early test of EBW heating with 28 GHz + 53 GHz.
	2.2. Engineering	
2.2-2	Give increased attention to the design and fabrication of the centerstack. It is quite complex, perhaps as complex as any element in the stellarator core.	We plan to complete refining the design of the centerstack and pass on the design package to PPPL for final design.

2.4. Diagnostics, Central I&C, Data Acquisition		
2.4-1	Plan for increased automation of large power supplies inherited from the ATF experiment and moved from the Y-12 location. This will speed operations and reduce manpower requirements.	While this is not needed for first plasma and completion of the QPS project, it may be cost effective to do this for the experimental program. We will examine the cost and schedule tradeoffs to optimize the operating resources.
2.6. Assembly and Commissioning		
2.6-1	Develop and implement an R&D plan for the shimming materials and process for assembly of the individual coil modules.	The R&D plan and techniques we are developing for NCSX will be adapted for QPS and discussed as part of the CD-2 documentation.
3.2. Schedule and Funding		
3.2-3	Provide resource loaded schedule to ensure Budget Authority/Budget Obligation compatibility prior to CD-2, Approve Performance Baseline.	A resource-loaded schedule incorporating budget guidance from DOE will be completed prior to CD-2 submission to ensure BA/BO compatibility.
3.2-4	Provide a fully integrated project schedule, including significant ES&H, procurement, DOE Reviews and Critical Decisions, and other milestones prior to CD-2. Include milestones for other facility projects procured with non-project funds.	A fully integrated project schedule including these items will be provided prior to CD-2.
3.2-5	Establish adequate Level 2 milestones in the Project Execution Plan to provide management control.	We have already done this for the earlier PPEP (Preliminary Project Execution Plan) for CD-1 submission and will update these milestones for the PEP as necessary.
4. Management		
4-4	Management should develop resource plans which account for both NCSX and QPS staffing needs over the life of the project.	This resource planning was done for the June 2002 QPS Project Validation Review. It will be updated for CD-2 and revised as the needs of both NCSX and QPS evolve.
4-6	Develop coordinated procurement plans between NCSX and QPS.	This is already planned for a manufacturing study of the QPS modular coil casting. The cost estimates already assume that PPPL procures the production coil winding forms, vacuum vessel, TF coils, and center stack assembly. The coordination will naturally occur as a result of this process.

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	5. Research Program Plans	
5-3	Implement the PVR recommendation to promptly bring into the program an experienced experimental physicist to be responsible for the physics program planning and development.	ORNL has committed to a "critical hire" slot for the QPS program for a senior experimentalist to develop the ORNL's compact stellarator program and stellarator collaborations. We have posted the position and held interviews at the Oct. 2003 APS meeting in Albuquerque. In addition, an experienced ORNL plasma physicist working on a collaborative experiment will be brought into the QPS program in FY 2005 (3-4 years before start of experimental operations) when Research Preparation funding is available for detailed planning of the experimental program and long-term diagnostic preparation.

III. Longer-Term Programmatic Items (before Operation and Continuing Items)

Item	CDR Panel Recommendation	QPS Team Response
	2.1. Physics	
2.1-4	Identify beta limit studies that can be done in the range of one to two percent, especially at the lower end.	**In progress**. Andrew Ware and Don Spong are looking at ways to lower the infinite-*n* ballooning stability limit to ~1% using COILOPT with Ohmic current and optimized currents in the nine different coil sets. This study will continue as part of the Research Preparation activities.
2.1-5	Develop alternative plasma heating scenarios if the proposed RF heating scenarios fail to achieve higher densities.	**In progress**. Dave Mikkelsen's (PPPL) transport analysis of what can be achieved with ECH alone gives interesting parameters with good confinement. In addition, recent results from the CHS and WEGA stellarators show heating at densities >6 times the ECH cutoff density. Dave Rasmussen and Lee Berry will also document the different rf heating (ECH+EBW, ICRF, LH) scenarios available to reach high density and the plans to test them on other experiments. These tasks are planned as part of the Research Prep activities. CAD drawings by Mike Cole show adequate access for NBI heating if all the rf scenarios fail, but NBI would require a major upgrade to the QPS facility.
	2.3. Heating	
2.3-1	Plan means of gas control and gas feed that will permit good control of the density.	A plan for the gas control and gas feed needed for QPS operations will be developed as part of the Research Preparation activities.
2.3-2	Maintain active participation in experimental groups performing HHFW and EBW heating.	Dave Rasmussen's group plans to continue their active participation in experimental groups doing HHFW and EBW heating as part of their program of developing rf heating.
	2.5. Power Systems, Site, and Utilities	
2.5-1	Verify functionality and modernize control systems of power supplies to allow efficient interface for operation prior to integrated system testing.	The power supplies will be tested on a dummy load provided by the QPS project as part of the relocation to the new building. We will examine modernization of the control systems (see 2.4-1)

2.6. Assembly and Commissioning		
2.6-2	Develop a detailed magnet system testing plan and required instrumentation.	This item is needed before commissioning QPS. It will be developed in preparation for CD-4 (Approve Start of Operation).
5. Research Program Plans		
5-1	Continue to develop the research plan, hardware requirements, and integrated system design to ensure that upgrade hardware can be accommodated when needed.	This will done as be a continuing activity under the Research Preparations budget.

IV. Recommendations Requiring No Specific Action, only Acknowledgment or Explanation

Item	CDR Panel Recommendation	QPS Team Response
	2.1. Physics	
2.1-3	Add magnetic field mapping at more than one toroidal location.	This would cause a significant delay in starting the experimental program because of the time needed to remove and reinstall the mapping equipment, obtain a good vacuum again, repeat the mapping measurements, and remove the mapping equipment again. This is not required for the NCSX project and is not thought to necessary in QPS as well. The tradeoffs and additional costs in the Project in doing this will be examined as part of the Research Preparation activities.
	2.3. Heating	
2.3-3	Explore avenues to implement low-power conventional ECH at earliest opportunity to smooth operation of first plasma.	**Completed**. ECH will be used for first plasma operation instead of Ohmic heating to allow a faster start of the experimental program.
	2.4. Diagnostics, Central I&C, Data Acquisition	
2.4-2	Make maximum use of common approaches with the NCSX project, to streamline design and procurement, and also to facilitate collaborative experiments involving staff from the two groups.	This has been a hallmark of both the NCSX and QPS projects for the past three years to the mutual benefit of both and of course will continue. No action is required other than to continue what we are already doing.
	3.2. Schedule and Funding	
3.2-6	Ensure that all start-up costs occurring at or after project completion are identified as operating expense vs. capital (TEC).	This requires no near-term action, but we will be careful to distinguish between MIE costs needed for project completion and those required for the experimental program phase (operating costs).

V. Duplications of Other Recommendations

Item	CDR Panel Recommendation	QPS Team Response
2.2-1	Evaluate field errors that are inherent in the design and due to coil imperfections for their impact on plasma performance. Island sizes should be assessed relative to requirements.	This recommendation is the same as 2.1-1.
2.2-4	Identify the steps necessary to manage the risks in developing a modular coil winding facility at UT, training and supervising the supporting staff, and integrating them into the project. Specifically, address: (1) Training and supervision of temporary technicians and graduate students; (2) Quality assurance; (3) Safety; and (4) Work planning, work authorization, and cost performance reporting.	This recommendation is the same as action item #2.
3.2. Schedule and Funding		
3.2-1	Work with the program office to develop supportable funding profile.	This recommendation is the same as action item #1.
3.2-2	The project should plan to meet all requirements for projects over $20 million as set forth in the DOE Order 413.3.	This recommendation is included in recommendation 2.2-3. No specific action is needed other than to ensure that these requirements are met throughout the project.
4. Management		
4-2	The Project Team should consider this to be a project greater than $20 million per DOE Order 413.1, and manage it accordingly.	This is the same recommendation as 3.2-2.
4-3	Update all project management documents to reflect current Order 413.1 requirements and the requirements of all additional guidance documents.	This is the same recommendation as 2.2-3.

4. Management		
4-7	Develop a plan to manage coil work being assigned to UT for accomplishment.	This is the same as action item #2 and recommendation 2.2-4.
5. Research Program Plans		
5-2	Re-order the experimental schedule to ensure that novel physics results are produced as early as possible in the program.	This is the same recommendation as 2.1-6.