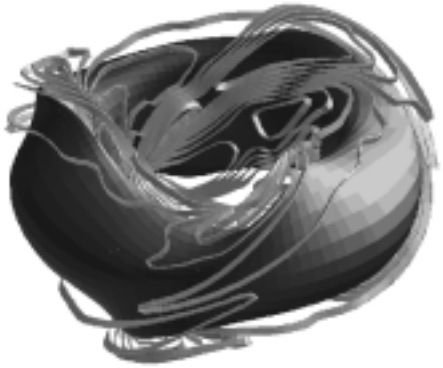
NCSX Memorandum



To: NCSX Engineering Team

CC: J. Schmidt, H. Neilson, P. Heitzenroeder, M. Zarnstorff, R. Simmons, J. Lyon

From: W. Reiersen

Date: 10/27/2000

Re: PVR Planning

A meeting was held on Friday afternoon, October 20, to discuss when the PVR should be held. It was determined that it would be prudent to postpone the PVR from December to the end of March. The Design, Cost, and Schedule Review (DCSR) would still be held in April. The purpose of the slippage is to assure that we have a solid story on both the engineering and physics sides for the PVR, thereby maximizing the likelihood of a successful PVR. It is also important that the DCSR be conducted in April to get construction funding in FY03. Slipping the PVR to the end of March is about as late as we can slip it within the constraints of the budget cycle.

The plain fact is that engineering and physics are inseparably intertwined. Right now, we do not have a free-boundary equilibrium that has both adequate surface quality and physics properties (at a size consistent with PIES calculations for the last closed flux surface). We appear closer to achieving these goals with modular coils than with saddles. Right now however, we do not have a modular coil design that we can point to and say will work. We appear closer to having a workable engineering design for saddles than modular coils. This is the dilemma. We really cannot choose between them until we have at least one concept that satisfies both physics and engineering requirements. The later PVR date gives us a bit of time to further develop the modular coil design and to determine whether adequate physics performance can be achieved with saddle coils.

Let's assume the PVR will be the week of March 28. I propose the following milestones for the timely evolution of the design and recommend monthly project meetings during which progress against the established milestones is reviewed.

November 13 Milestones

- DOE expectations understood
- Physics and engineering plans are in place and fully coordinated
- Budgets and manpower loadings set

December 20 Milestones

- Down-selection between saddles and modular coils made
- Machine size fixed

- Coil geometry fixed
- Requirements (including reference scenario definition, flexibility, and trim coils) set
- Option for bringing power to C-site selected
- Concepts for handling heat loads on plasma facing surfaces developed

January 24 Milestone

- Physics and engineering ready to commit to PVR (60 days notice)
- PVR plans and documentation requirements established
- Configuration of internal hardware for power handling set
- Port geometry and port allocations set
- Site study completed
- Control system concept developed
- Configuration-specific WBS developed
- Requirements for ancillary systems developed
- R&D required for PVR completed

February 28 Milestones

- Technical basis for PVR complete and internally reviewed
- Cost and schedule basis complete and internally reviewed
- First draft of PVR documentation complete

March 14 Final PVR documentation posted on Web

March 28 PVR

The milestones highlight what we already know – even with the slippage of the PVR, we are on a very tight schedule. In the following paragraphs, I take a first cut at tasks, target completion dates, and assignment of lead responsibility. Feedback on this task list would be much appreciated.

Engineering management

- Contact DOE re expectations for PVR (Simmons -10/31)
- Develop engineering plans for PVR, coordinate tasks with physics and management (Reiersen - 11/7)
- Reconcile budgets, manpower loading, and task assignments (Reiersen - 11/13)
- Establish initial documentation requirements (Heitzenroeder - 11/13)
- Update WBS to be design specific (Reiersen, Simmons – 1/17)
- Finalize PVR documentation requirements (Reiersen - 1/24)

R&D

- Complete testing of cabled conductor to determine stiffness in “tight” sleeve (Nelson – 11/13)

- Analyze test fixture (Fan – 12/13)

Industrial involvement

- Determine strategy to get US industry input on manufacturing methods, feasibility, and cost (Nelson, Heitzenroeder – 11/13)
- Determine strategy for involving foreign industry, particularly in Russia, Ukraine, and S. Korea (Nelson, Heitzenroeder – 11/13)
- Determine how to best communicate design information to industry (Brown – 11/13)
- Provide initial input on manufacturing methods, feasibility, and cost for down-selection (Nelson, Heitzenroeder – 12/13)
- Provide final input for PVR (Nelson, Heitzenroeder – 2/13)

Requirements

- Draft design requirements, constraints, and criteria (Reiersen – 11/13)
  - Initial issue (Reiersen – 11/13)
  - Establish coil currents for reference scenario (Reiersen – 11/13)
  - Establish requirements for power handling (Reiersen – 11/20)
  - Establish auditable (i.e. coil currents) flexibility requirements (Reiersen – 11/30)
  - Establish trim coil current requirements (Reiersen – 12/6)
- Review and revise physics requirements as appropriate (Zarnstorff – 12/20)
- Establish requirements for ancillary systems (Reiersen – 1/24)

Complete development of modular coil concept for down-selection

- Develop structural design concept (Williamson – 11/13)
- Provide initial assessment of structural adequacy (Fan – 12/13)
- Add cryostat, gaps, and port extensions (Williamson, Cole – 11/30)
- Incorporate concepts for internal hardware (Williamson – 12/13)
- Develop trim coil concepts for modulars
  - Assess what trim coil helicities are required to produce good surfaces (Brooks - 11/13)
  - Perform trade studies to determine trim coil geometry and location (Brooks - 11/30)
  - Incorporate in machine configuration (Williamson - 12/13)
- Develop assembly scheme (Williamson – 12/13)
- Provide access assessment (Cole – 12/13)
- Update cost estimate (Nelson – 12/20)
- Pick fabrication methods (VV, coil structures, etc.) (Nelson – 12/20)
- Provide plausibility assessment of modular coil option (Nelson – 12/20)

Complete development of saddle coil concept for down-selection

- Identify better saddle coils (Brooks – 11/13)

- Explore reduced shell segmentation options (Brown – 11/13)
- Develop trim coil concepts for saddles
  - Assess what trim coil helicities are required to produce good surfaces (Brooks - 11/13)
  - Perform trade studies to determine trim coil geometry and location (Brooks - 11/30)
  - Incorporate in machine configuration (Brown - 12/13)
- Provide access assessment (Cole – 12/13)
- Incorporate concepts for internal hardware (Brown – 12/13)
- Pick fabrication methods (VV, coil structures, etc.) (Nelson – 12/20)
- VV and first wall stuff might be discriminators
- Update cost estimate (Nelson – 12/20)
- Provide plausibility assessment of saddle coil option (Nelson – 12/20)

Complete concept development for PVR

- Finalize the configuration of internal hardware for power handling (Cole, Goranson – 1/24)
- Finalize the port geometry and port allocations (Cole – 1/24)
- Complete structural analysis required to establish plausibility (Fan – 2/14)
- Define assembly sequence and time requirements (Nelson – 2/14)
- Develop control system concept (Kessel– 1/24)

Power systems concept development

- Develop preferred power system option for saddle and modular coils, provide cost input to Nelson (Hatcher, Neumeyer – 12/13)

Field/size trade study

- Provide curve of B v. R for li383 plasma (Zarnstorff – 11/13)
- Perform assessment of cost and feasibility at larger size (Reiersen, Nelson – 12/13)

Site study

- Survey alternate sites at PPPL, provide recommendation on preferred site (Neumeyer – 1/24)

Super conducting option study

- Provide assessment of the feasibility and cost of using superconductor in place of cryo-cooled copper (Schultz – 11/13)

Site preparation and ancillary system design

- Develop design concepts and cost estimates for site preparation and ancillary systems (Neumeyer, Dudek – 2/14)

Manpower requirements for these tasks were reviewed with Phil Heitzenroeder and Brad Nelson. Minimum resource requirements are summarized (by FTE) and associated costs estimated below. ORNL engineering requirements are about $800K. PPPL engineering requirements are about $850K.

ORNL

1.00 Dave Williamson

1.00 Mike Cole

0.50 Paul Goranson

0.50 Brad Nelson

0.50 Greg Jones

0.20 Paul Fogarty

0.20 Bob Benson

$50K R&D (incl. Stereo lithography models)

$15K Travel

$45K M&S (Boeing, AES, Everson)

Total ~$800K

PPPL

0.40 Phil Heitzenroeder

1.00 Art Brooks

0.60 HM Fan

1.00 Wayne Reiersen

0.50 Tom Brown

0.10 Larry Dudek

0.05 Jim Chrzanowski

0.20 Ron Hatcher

0.10 Charles Neumeyer

0.05 George Barnes

$10K Travel

$32K M$S (Georgiyevskiy)

Total ~$850K