NCSX Program Advisory Committee (PAC-6) Recommendations Tracking Log 7/9/04

Recom-mendation Number	**Recommendation / Plan / Status**
PAC6-1 **Closed**	*PAC-6 Report:* The PAC agrees that the demonstration of design maturity of the modular coil system and vacuum vessel is of central importance for the upcoming PDR. *Project Response / Status (July, 2004):* The PDR demonstrated a level of design maturity in all systems sufficient to establish the baseline, with the modular coils and vacuum vessel receiving the strongest technical emphasis. Subsequently, a successful FDR of these two components was held. *Primary Project Responsibility:* Hutch Neilson
PAC6-2 **Closed**	*PAC-6 Report:* Minor adjustments of the coil shape should lead to improvements in the clearance between plasma and the vacuum vessel. This will add to flexibility in the machine and potential improvements to planned divertor operation in later phases of the program. *Project Response / Status (July, 2004):* Considerable effort was devoted to increasing coil-plasma spacing in the coil design, and maximizing plasma-vessel spacing, subject to assembly constraints, in the vacuum vessel shell design. As a result there were gains in flexibility for divertors. *Primary Project Responsibility:* Mike Zarnstorff
PAC6-3 **Closed**	*PAC-6 Report:* The committee recommends that the physics coil design be frozen in the immediate future. *Project Response / Status (July, 2004):* The project adopted the M50 coil design shortly after the PAC-6 meeting. It has been the basis for subsequent design development, which was reviewed at the PDR and FDR. *Primary Project Responsibility:* Mike Zarnstorff

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PAC6-4 **Closed**	*PAC-6 Report:* Studies of flexibility and start-up are recommended for the PDR to assure that the new coil set is fully qualified. While variations are minor, the team must ensure that the design presented at the PDR is at least as qualified with respect to the physics issues as designs presented at previous PAC meetings and, more importantly, addresses issues delineated at the successful CDR. *Project Response / Status (July, 2004):* The entire physics analysis could not be repeated for the new coils due to resource limitations. Re-analysis of selected cases with the new coils indicates that the new coils give plasma characteristics as good or better than the earlier coils. In particular, for similar condition, the new coils produce lower effective-ripple and larger coil-vessel separation, and generally confirms that the differences in physics properties are minor or positive. *Primary Project Responsibility:* Mike Zarnstorff.
PAC6-5 **Closed**	*PAC-6 Report:* Assure that the configuration has reasonable flux surface quality and confinement at intermediate beta values achievable at the early stages of the project. *Project Response / Status (July, 2004):* Flux surface quality has been analyzed for several cases at both β=0 (vacuum) and β=3% showing that acceptable surfaces can be accessed. *Primary Project Responsibility:* Mike Zarnstorff.

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Recom-mendation Number	**Recommendation / Plan / Status**
PAC6-6 **Closed**	*PAC-6 Report:* Engineering design to accommodate electric breaks in the coil support castings is a critical item for the PDR. The electrical break may introduce significant complexities in the design and manufacturing process, and may have implications in machine operation and longevity. Issues need to be identified and a plan formulated for addressing them. The need for these breaks should be fully justified for the PDR. *Project Response / Status (July, 2004):* The poloidal break issue was a subject of a peer review held on Jan. 23, 2003. Issues and rough costs were identified to support the decision. The justification for having a break is that the time constant is too long. compared to plasma control time scales, without it. The poloidal break reduces it by about a factor of 3, to an acceptable range. Manufacturing issues are being addressed in detail as part of the manufacturing development R&D activities being carried out in industry. Manufacturer feedback has been incorporated into the poloidal break design. The structural performance issues were analyzed by the NCSX team for the PDR. *Primary Project Responsibility:* Wayne Reiersen.
PAC6-7a **Closed**	*PAC-6 Report:* The general plan for diagnostics is developing satisfactorily. Diagnostic needs and port access requirements strongly impact the design of the vacuum vessel, which needs to be frozen soon. Further attention should be given to needs for 3D diagnostics. What unique diagnostics are needed because of the 3D nature of the physics? *Project Response / Status (July, 2004):* Since the last PAC meeting, there has been considerable progress on improving diagnostic access both through increasing the number of ports and through optimizing the orientation of the ports. Part of the research program is currently focused on an ambitious effort to develop an optimized set of magnetic sensors that will provide input for a 3-D equilibrium reconstruction. Such 3-D equilibria will be essential in the interpretation of diagnostic data. The project recognizes a need as well for internal 3-D measurements, for example, of flux surface topology. While e-beam mapping may provide such data for vacuum surfaces, development of a practical means of making such measurements with plasma (perhaps through multiple x-ray tomography arrays) will certainly be encouraged by the Project in community discussions leading up to and including the Research Forum planned for mid-2005. The additional ports will hopefully provide space for such developments. *Primary Project Responsibility:* David Johnson.

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PAC6-7b **Closed**	*PAC-6 Report:* Magnetic diagnostics external to the vacuum vessel need definition prior to finalization of the vacuum vessel, coil design, bus work, and the like. *Project Response / Status (July, 2004):* Many of the ex-vessel magnetic diagnostics were incorporated into the design of the related coil systems. The space envelope required for those attached to the vessel was defined and included in the vessel design. The budget for ex-vessel magnetic diagnostic sensors and their installation is included in the project baseline approved at CD-2. *Primary Project Responsibility:* Mike Zarnstorff.
PAC6-8 **Closed**	*PAC-6 Report:* The deployment of edge/divertor diagnostics needs clarification with respect to the timing of PFC upgrades. *Project Response / Status (July, 2004):* The plan presented to PAC-7 (see presentations by Stratton and Mioduszewski) mentions PFC upgrades including wall panels in Phase 3 (1.5 MW NBI phase) and a liner in Phase 4 (3.0 MW NBI phase). Edge/divertor diagnostic capability planned for Phase 3 includes filtered, fast visible cameras and an IR camera with standard video frame rate. Both cameras can be moved to different positions. Also included in Phase 3 are visible filterscopes and a visible survey spectrometer at fixed positions. Panel-mounted Langmuir probes and a probe movable between shots to scan the SOL are also included along with fast pressure gauges. In Phase 4, these will be supplemented with filtered 1-D CCD cameras at fixed positions, edge Thomson, CHERS and FIR interferometer channels, and a fast lost ion probe. *Primary Project Responsibility:* David Johnson.

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PAC6-9 **Closed**	*PAC-6 Report:* No plan for fluctuation diagnostics has been presented. These are critical in a device that is expected to be anomalous transport dominated. Thought should be put into these diagnostic needs, and the impact of these diagnostics on the vessel design should be assessed. *Project Response / Status (July, 2004):* While it is possible to imagine implementing several traditional fluctuation diagnostics, including reflectometry, beam emission spectroscopy, microwave scattering, and a heavy ion probe on NCSX, no conceptual studies have been done to lay out such diagnostics. The present diagnostic implementation plan calls for a fluctuation diagnostic (technique TBD) in Phase 5, with design work starting ~6 years from now. It is hoped that the Project can benefit from progress in this rapidly evolving field in selecting the optimum tools for these measurements. In the present machine design, excellent diagnostic access exists from nearly all directions to the elongated plasma cross-section region. *Primary Project Responsibility:* David Johnson.
PAC6-10 **Closed**	*PAC-6 Report:* Position indexing of the diagnostics is an important issue for a 3D device. A plan needs to be developed. A procedure for land-marking the in-vessel components, external diagnostics, vacuum vessel and other components that are referenced to the coil coordinates is needed. *Project Response /Status (July, 2004):* The vacuum vessel, port extensions, and modular coils will all have permanently mounted metrology targets. Six targets on each field period of the vacuum vessel shell (total of 18) will be accessible from both the inside and outside of the vessel. At least three metrology systems will be available for measurement, including multi-link coordinate measurement systems (Romer and Faro arms), laser tracker, and a laser GPS system. The relative positions of the vessel and coil set must be tracked due to temperature changes so the location of components attached to the vessel can be referenced to the magnetic field. *Primary Project Responsibility:* Wayne Reiersen.

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Recom-mendation Number	**Recommendation / Plan / Status**
PAC6-11 **Closed.**	*PAC-6 Report:* The NCSX team has done a good job in identifying the key engineering tasks that need to be accomplished in coil fabrication and testing prior to the PDR. In addition, a number of further tests [tasks?] should be considered including an analysis of the field errors produced by realistic bus work and modular coil feed-throughs prior to the PDR. *Project Response / Status (July, 2004):* Field error analysis was used to determine the optimum poloidal location for leads on the modular coils. The coil feeds use coaxial cable close to the machine, to minimize field errors in the plasma. *Primary Project Responsibility:* Wayne Reiersen.
PAC6-12 **Closed**	*PAC-6 Report:* An R&D plan for the new cladding/cooling system for the modular coils needs to be developed for the PDR. *Project Response / Status (July, 2004):* A successful design and R&D plan for the cladding and chill plates were presented at the PDR. The R&D plan, which addresses fabrication issues, is now under way, in preparation for winding the twisted racetrack demonstration coil *Primary Project Responsibility:* Brad Nelson.
PAC6-13 **Closed**	*PAC-6 Report:* We are concerned about the significant amount of work planned between the PDR and the FDR. This may result in a delay in the FDR. *Project Response / Status (July, 2004):* Both reviews were successfully completed. *Primary Project Responsibility:* Wayne Reiersen.

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Recom-mendation Number	**Recommendation / Plan / Status**
PAC6-14 **Closed**	*PAC-6 Report:* NCSX and QPS projects overlap heavily in staff and schedule. Both projects should clearly coordinate and verify that staffing and schedule are consistent. *Project Response / Status (July, 2004):* Since PAC-6, the NCSX project completed a successful PDR and FDR and received CD-2, while QPS had a successful CDR and CD-1. The partnership provides flexibility in project staffing that, together with good planning and coordination, has met the needs of both projects. *Primary Project Responsibility:* Hutch Neilson and Jim Lyon.