DESIGN REVIEW DOCUMENTATION – RESULTS

Title: Inner PF Coil PDR _____ **WP#:** 2254 __ (ENG-032)

Type of Review: ☐ **Peer** ☐ **CDR** ☒ **PDR** ☐ **FDR**

Cog Individual: S. Raftopoulos _____ **Date of Review: 12/15/17**_____

Review Board and Attendees:

Chair: T. Stevenson _____	F. Malinowski - QA _____	W. Wang_____
M. Smith_____	J. Levine _____	D. Downing _____
J. Petrella _____	V. Riccardo _____	Y. Zhai _____
R. Ellis _____	A. Brooks _____	R. Feder _____
J. Dellas _____	W. Que _____	J. Fang _____
F. Hoffmann_____	B. Beck (MIT)_____	M. Jaworski _____
L. Dudek_____	I. Dixon (NHMFL) _____	C. Ciummo _____
D. Loesser _____	R. Fair (JLAB)*_____	C. Neumeyer*_____
S. Gerhardt _____	M. Kalish_____	I. Zatz _____
P. Titus _____	S. Weidner _____	A. Indelicato (DOE-PSO)_____
_____	_____	_____

Items Reviewed:	**Sat.**	**Unsat.**	**Comments or n/a if not applicable**
Appropriate requirements identified	☒	☐	_____
Development plans and schedules	☒	☐	_____
Regulatory compliance including USI/USID and NEPA	☒	☐	NSTXU Recovery _____
Disposition of CHITS from previous reviews	☒	☐	_____
Cost objectives	☒	☐	_____
Other review objectives addressed	☐	☐	n/a _____

SUMMARY OF RESULTS:

This review covered the development of the PF1 ABC coil set requirements, design, analysis, testing, procurement strategy, cost, schedule and risks. The PF1 coil set, or divertor coils, provide field that enables diverted plasma operation, flux expansion, inner gap control influence, and sweep of divertor strike points. The requirements drive coil parameters within space constraints. The design covered the PF1 ABC upper and lower designs which simplify the previous design in several key ways for manufacturability and reliability. The coil cross sections were therefore iterated to achieve physics requirements, space constraints and locations, thermal limits for material properties with margin regarding pulse lengths and cyclic rates, manufacturing elements including G11 fillers, kapton tape and glass wrapping in layers, and the deletion of the winding mandrel to improve electrical impulse testing. Conductor sizing, key stoning, and cooling channels were discussed for AB&C coils. Techniques for grit blasting, winding,

and VPI processing were presented making use of best past practice. Voltage standoff safety factors are greater than 10. The lead areas were also discussed in detail. A build tolerance study was presented and found to be acceptable for the requirements; however given the as-built dimensions and alignment criteria for the core torus a peer review has been scheduled to specifically address these issues and then finalize the PF1A conductor dimensions. (During the writing of this report but prior to its approval, a successful peer review was held, a conductor size determined, and paths forward determined for conductor procurement, polar region design, TF alignment, and concomitant PFC loading. Another peer review will be held to address TF PF5 alignment and tilt issues.) Interfaces were presented and discussed. Based on design criteria and allowables, analysis as presented addressed load cases for normal operation, post-disruption, and fault scenarios and included interfaces, supports, coil conductors, insulation and conductor/insulator interface. Based on 96 plasma shape scenarios, EM, thermal, abnormal, gravity, and pre-loads were considered. The inner PF coil, structure, and interconnection analysis concluded that the design met requirements with a few minor details that need additional study for the FDR. Insulation property testing has been planned; five series of tests with multiple samples will undergo mechanical testing including CTD shear testing with special fixtures. Acceptance testing will include dimensional tests, leak checking, flow tests, hydrostatic tests, electrical testing with turn to turn testing. Fabrication at multiple vendors will include continuous oversight with some QA/QC coverage at key steps. Manufacturing improvements include VPI vacuum changes and procedure changes, better documentation, prototyping, and the aforementioned additional testing. Project management details were presented for WBS milestones, strategy of multiple vendors, risks, cost, schedule, and staffing plans. In parallel with design a WAF has been generated and is in preliminary WAF review. Twenty four chits were generated and accepted for implementation or further assessment.

Disposition: [check one]

_____ **Acceptable**

X_____ **Acceptable pending resolution of concerns**- CHITS identified above must be resolved prior to installation.

_____ **Incomplete -** Additional design work is required prior to another design review.

_____ **Unsuccessful** – Corrective actions must be taken and another review process must be initiated.

RLM Concurrence: C. Neumeyer Charles L. Neumeyer Digitally signed by Charles L. Neumeyer DN: cn=Charles L. Neumeyer, o=PPPL, ou, email=neumeyer@pppl.gov, c=US Date: 2017.12.20 [illegible] -05'00' Date: _____

DR Chairperson Signature: T. Stevenson Timothy N. Stevenson Digitally signed by Timothy N. Stevenson DN: cn=Timothy N. Stevenson, o=PPPL, ou=ENGR, email=tstevens@pppl.gov, c=US Date: 2017.12.20 11:27:42 -05'00' Date: _____

Distribution: Review Board Members, Operations Center, Cognizant Design Engineer, System Engineer(s), Head, Office of Project Management, Fire Protection Engineer, Attendees, QA, ES&H, Security, Requesting & Performing Dept. Heads, Head of Engineering