NCSX Work Approval Form (WAF)

WBS Number: 44
WBS Title: Control and Protection Systems
Job Number: 4401
Job Title: Control and Protection Systems
Job Manager: Raki Ramkrishnan

Description:
This WBS element consists of the following subsystems: (1) Electrical Interlock Systems - This WBS element consists of the effort to design, fabricate, and install an electrical interlock system for NCSXd which ensures the proper configuration of the power system in accordance with the commanded state from the NCSX control room and access control systems, and which provides coordinated fast fault response of the power supplies when faults are detected. (2) Kirk Key Interlock System - This WBS element consists of the effort to design, procure, fabricate, and install kirk key interlocks for NCSX. (3) Real Time Control Systems - This WBS element consists of the effort to develop the specification of the hardware requirements and software algorithms to be provided by WBS 5 (Central I&C) for the real time digital feedback control of the power supply system, including the high-speed digital input and output links. (4) Instrumentaion Systems - This WBS element consists of the effort to design, specify, procure, install, and implement current and voltage measurements for the NCSX coil systems. (5) Coil Protection Systems.

Schedule:

Approvals:

S. Ramakrishnan
Digitally signed by S. Ramakrishnan
DN: cn=S. Ramakrishnan, c=US, o=Princeton Plasma Physics Laboratory, ou=National Compact Stellerator Experiment, email=sramakri@pppl.gov
Date: 2007.07.06 14:21:27 -04'00'

Job Manager _____ Date _____

Al von Halle
Digitally signed by Al von Halle
DN: CN = Al von Halle, C = US
Date: 2007.07.09 07:38:57 -04'00'

Responsible Line Manager _____ Date _____

Hutch Neilson
Digitally signed by Hutch Neilson
DN: CN = Hutch Neilson, C = US, O = PPPL
Date: 2007.07.09 08:26:33 -04'00'

Project Manager _____ Date _____

Mike Williams
Digitally signed by Mike Williams
DN: cn=Mike Williams, o=PPPL, ou=Engineering, email=williams@pppl.gov, c=US
Date: 2007.07.09 08:48:28 -04'00'

Engineering Department Head _____ Date _____

NCSX June 2007 ETC
TABLE I - DESIGN LABOR

WBS Number: 44

WBS Title: Control and Protection Systems

Job Number: 4401

Job Title: Control and Protection Systems

Job Manager: Raki Ramkrishnan

Description: This is a LOE effort for design intergration, interface definition, and oversight of diagnostic systems design, fabrication, and installation

		K$		Labor Hours					Basis of Estimate
Task Description	Activity	M&S	Travel	EASM	ECEM	EEEM	EESM	EETB	(See Notes on Basis of Estimate Below)
WBS 441 Electrical Interlocks									
Design Interlock sys	441-095			40		80	80		
Install Interlock sys	441-097					80	80		Needed prior to coil energization
PLC Specification	441-100					24	56		
Prep Block diagrams	441-105					24	80		
PLC CWD's & Cabling	*441-110*					16	240	320	
deliver PLC	441-115	$70K							
Program PLC Logic	441-120					64	240		Needed prior to coil energization
Program Control pages	441-125				40	32	120		Needed prior to coil energization
Pre-commissioning tests	441-130	$1K				40	120		Needed prior to coil energization
Install I/O Cabling	441-135	$38K		160		40	80	400	Needed prior to coil energization
WBS 442 Kirk Key Interlocks									
Kirk Keys-Dsn	442-1-2			80		40	40		
Kirk Keys-Procure	442-1-4	$10K				8	24		
Kirk Keys-Install	442-1-6	$15K				16	24	80	
Kirk Keys-Commission	442-1-8					16	20	20	Needed prior to coil energization
WBS 443 Real Time Control Systems									Needed prior to coil energization
Develop Control Algorithms-Dsn	443-1-2					80			Needed prior to coil energization
WBS 444 Instrument Systems									
DC Potential Transducers (DCPTs)-Dsn	444-2-2			40		24			
DC Potential Transducers (DCPTs)-Procure	444-2-4	$6K		16					
DC Potential Transducers (DCPTs)-Install	444-2-6			16		16	24	160	
DC Potential Transducers (DCPTs)-Commission	444-2-8					24	24	60	Needed prior to coil energization
DC Shunts-Dsn	444-3-2			32		24			
DC Shunts-Procure**N/R**	444-3-4								
DC Shunts-Install**N/R**	444-3-6								
DC Shunts-Commission**N/R**	444-3-8								
Signal Conditioning & Cabling-Dsn	444-4-2			24		480			
Signal Conditioning & Cabling-Procure	444-4-4	$12K				16			
Signal Conditioning & Cabling-Install	444-4-6					24		280	
Signal Conditioning & Cabling-Commission	444-4-8					48	40	40	Needed prior to coil energization

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TABLE I - DESIGN LABOR

WBS Number: 44									
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WBS 445 Coil Protection Systems									
Ground Fault Protection-Dsn	445-1-2			40		160	16		
Ground Fault Protection-Procure	445-1-4	$18K				16			
Ground Fault Protection-Install	445-1-6			8		40	48	120	
Ground Fault Protection-Commission	445-1-8					24	24	32	Needed prior to coil energization
Overload Protect-Write spec and approve	445-2-105					80			
Overload Protect-Design	445-2-110			32		96	32		
Overload Protect-Fabr 4 chassis	445-2-115					48	120		
Overload Protect-Test 4 units	445-2-120					32	32		
Overload Protect-Install & Rack wiring	445-2-125					48	77		
Overload Protect-Write & perform ISTP	445-2-130					32	32		Needed prior to coil energization
Overload Protect-Documentation	445-2-135			64		32			Needed prior to coil energization
Overload Protection&cabling design,procure instl	445-2-140	$13K		80		96	45	96	Needed prior to coil energization
Totals		**$183K**	**$0K**	**632**	**40**	**1920**	**1718**	**1608**	
Notes on the Basis of Estimate									
(1) Design and Fabrication/Installation									
Estimate based on estensive experience of engineer performing similar tasks at PPPL and EBASCO - e.g. recent experience on NSTX. This is basically a job modifying existing PPPL systems and re-installing for NCSX. Design and engineering estimates developed based on assessements of the number of drawings needed (new or modified), the effort to reconfigure existing designs, interfaces with other systems, supervision of on-site contractors, and all necessary re-activation and pre-operational testing needed.									
(2) M&S									
M&S estimated based on similar recent procurements and needed interfaces with installation contractors - this will be Davis-Bacon covered, except tor those activities within the Test Cell.									

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TABLE II - Materials and Subcontracts

WBS Number: 44

WBS Title: Control and Protection Systems

Job Number: 4401

Job Title: Control and Protection Systems

Job Manager: Raki Ramkrishnan

Materials and Subcontracts (M&S)	Material	Labor	Basis of Estimate
Description - inlcuded in Table I			

NCSX June 2007 ETC
TABLE III - Fabrication/Assembly Installation

In-house Fabrication and Assembly and Installation
Included in Table I

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TABLE IV - Uncertainty of Estimate and Residual Risk Assessment

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Uncertainty of the Estimate

	High	Medium	Low	Uncertainty of Estimate (%)	Comments/Other Considerations
Design Maturity		X		-10%/+15%	Requirements still evolving, but similar to other projects' designs
Design Complexity			X		Known technology from previous PPPL devices

Note: High/Medium/Low uncertainty assessment from Job Manager. Uncertainty range based on AACEI recommended practice 18R-97 as amended for NCSX.

Residual Impacts

Job	Risk Description	Likelihood of Occurring	Mitigation Plan	Basis of estimate	Cost Impact Low	Cost Impact High	Schedule Impact Low	Schedule Impact High
NONE								

Notes:
[1] Low cost and schedule impacts are considered the minimum (0-percentile) impacts should the event occur.
High cost and schedule impacts are considered the maximum (100-percentile) impacts should the event occur
[2] Cost impacts should be entered as man-hours (by demographic) and M&S direct cost under basis of estimate.
Cost impacts should NOT include standing army costs which are separately calculated from the schedule impact
Project control is reponsible for quantifying the low and high cost impacts based on the labor hours and M&S identified
[3] The schedule impacts should be entered as the min and max impacts on the critical path.
If there is no critical path impact then the schedule entries should be zero.
[4] Likelihood of occurrence should be entered consistent with our risk classification methodology, i.e.
VL= Very Likely (P>80%), L=Likely (80%>P>40%), U=Unlikley (40%>P>10%), VU=Very Unlikely (P<10%), NC=Non-credible (P<1%)