

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) Instrumentation 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:

Job Manager

Date

Responsible Line Manager

Date

Project Manager

Date

Engineering Department Head

Date

**NCSX June 2007 ETC
TABLE I - DESIGN LABOR**

WBS Number: 44									
WBS Title: Control and Protection Systems									
Job Number: 4401									
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Job Manager: Raki Ramkrishnan									
Description: This is a LOE effort for design intergration, interface definition, and oversight of diagnostic systems design, fabrication, and installation									
Task Description	Activity	K\$			Labor Hours				Basis of Estimate (See Notes on Basis of Estimate Below)
		M&S	Travel	EASM	ECEM	EEEM	EESM	EETB	
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		
<i>PLC CWD's & Cabling</i>	<i>441-110</i>					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									
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								
WBS Title: Control and Protection Systems								
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Job Manager: Raki Ramkrishnan								
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
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
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 assessments 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 for those activities within the Test Cell.								

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TABLE II - Materials and Subcontracts

WBS Number: 44									
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Job Manager: Raki Ramkrishnan									
Materials and Subcontracts (M&S)									Basis of Estimate
		Material				Labor			
Description - included in Table I									

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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 ACEI recommended practice 18R-97 as amended for NCSX.

Residual Impacts

Job	Risk Description	Likelihood of Occurring	Mitigation Plan	Basis of estimate	Cost Impact		Schedule Impact	
					Low	High	Low	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 responsible 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=Unlikely (40%>P>10%), VU=Very Unlikely (P<10%), NC=Non-credible (P<1%)

Activity ID	MILEstones (level 2 & 3)	Activity Description	Duration (work days)	Baseline Start	Baseline Finish	Shifts	Total Float	% cmplt	Proposed Budgeted	FY07						
										FY07	FY08	FY09	FY10	FY11	FY12	
44 - Control and protection Systems																
Job: 4401 - Control & Protection-RAMAKRISHNAN																
441 - Electrical Interlocks																
441-095		Design Interlock sys	65	01JUN09*	31AUG09		241		30,948.00	■ EA/SB =40hr ; EE//EM =80hr ; ■ EE//SM =80hr ;						
441-097		Install Interlock sys	40	01SEP09	27OCT09		241		26,431.48	■ EE//EM =80hr ;						
441-100		PLC Specification	20	02MAR09*	27MAR09		75		12,493.28	■ EE//EM =24hr ; EE//SM =56hr ;						
441-105		Prep Block diagrams	20	30MAR09	24APR09		75		16,010.72	■ EE//EM =24hr ; EE//SM =80hr ;						
441-110		PLC CWD's & Cabling	40	27APR09*	22JUN09		75		63,679.68	■ EE//EM =16hr ; EE//SM =240hr ; ■ EE//TB =320hr ;						
441-115		deliver PLC	130	23JUN09	06JAN10		75		98,920.77	■ 41=70\$;						
441-120		Program PLC Logic	45	07JAN10	10MAR10		75		48,189.60	■ EE//EM =64hr ; ee/sm=240						
441-125		Program Control pages	40	11MAR10	05MAY10		75		30,509.20	■ EC//EM =40hr ; EE//EM =32hr ; ■ EE//SM =120hr ;						
441-130		Pre-commissioning tests	20	06MAY10	03JUN10		75		27,004.00	■ 41=01\$; EE//EM =40hr ; ■ EE//SM =120hr ;						
441-135		Install I/O Cabling control & protection	90	25FEB10	01JUL10		75		127,497.20	■ 41=38\$; EA/SB =160hr ; ■ EE//EM =40hr ; EE//SM =80hr ; ■ EE//TB =400hr ;						
442 - Kirk Key Interlocks																
442-1-2		Kirk Keys-Dsn	40	01OCT09*	25NOV09		45		23,657.60	■ EA/SB =80hr ; EE//EM =40hr ; ■ EE//SM =40hr ;						
442-1-4		Kirk Keys-Procure	65	30NOV09	10MAR10		45		19,434.40	■ 41=10\$; EE//EM =08hr ; ■ EE//SM =24hr ;						
442-1-6		Kirk Keys-Install	90	01APR10*	06AUG10		30		34,702.00	41=15\$; EE//EM =16hr ; ■ EE//SM =24hr ; EE//TB =80hr ; ■						
442-1-8		Kirk Keys-Commission	20	09AUG10	03SEP10		30		7,643.00	■ EE//EM =16hr ; EE//SM =20hr ; ■ ■ EE//TB =20hr ; ■						
443 - Real Time Control Systems																
443-1-2		Develop Control Algorithms-Dsn	65	01OCT09*	13JAN10		195		14,772.00	■ EE//EM =80hr ;						
444 - Instrument Systems																
444-2-2		DC Potential Transducers (DCPTs)-Dsn	40	01OCT09*	25NOV09		100		9,536.40	■ EA/SB =40hr ; EE//EM =24hr ;						
444-2-4		DC Potential Transducers (DCPTs)-Procure	65	30NOV09	10MAR10		100		10,633.92	■ 41=06\$; EA/SB =16hr ;						
444-2-6		DC Potential Transducers (DCPTs)-Install	40	11MAR10	05MAY10		100		21,894.32	■ EE//EM =16hr ; EE//SM =24hr ; ■ EE//TB =160hr ; EA/SB =16hr ;						
444-2-8		DC Potential Transducers (DCPTs)-Commission	15	06MAY10	26MAY10		100		13,041.60	■ EE//EM =24hr ; EE//SM =24hr ; ■ EE//TB =60hr ;						
444-3-2		DC Shunts-Dsn	20	01OCT09*	28OCT09		240		8,515.44	■ EA/SB =32hr ; EE//EM =24hr ;						
444-4-2		Signal Conditioning & Cabling-Dsn	130	01JUL09*	14JAN10		54		90,210.87	■ EA/SB =24hr ; EE//EM =480hr ;						
444-4-4		Signal Conditioning & Cabling-Procure	65	15JAN10	15APR10		54		20,138.40	■ 41=12\$; EE//EM =16hr ;						
444-4-6		Signal Conditioning & Cabling-Install	65	16APR10	19JUL10		54		27,638.00	■ EE//EM =24hr ; EE//TB =280hr ; ■						
444-4-8		Signal Conditioning & Cabling-Commission	10	20JUL10	02AUG10		54		18,240.40	■ EE//EM =48hr ; EE//SM =40hr ; ■ ■ EE//TB =40hr ;						
445 - Coil Protection Systems																
445-1-2		Ground Fault Protection-Dsn	65	02FEB09*	01MAY09		66		35,854.56	■ EA/SB =40hr ; EE//EM =160hr ; ■ EE//SM =16hr ;						
445-1-4		Ground Fault Protection-Procure	65	18AUG09*	17NOV09		81		28,383.62	■ 41=18\$; EE//EM =16hr ;						

Activity ID	MILE-stones (level 2 & 3)	Activity Description	Duration (work days)	Baseline Start	Baseline Finish	Shifts	Total Float	% cmlpt	Proposed Budgeted						
										FY07	FY08	FY09	FY10	FY11	FY12
445-1-6		Ground Fault Protection-Install	75	18NOV09*	16MAR10		81		25,626.96						
445-1-8		Ground Fault Protection-Commission	70	17MAR10	23JUN10		81		10,720.96						
445-2-105		Overload Protect-Write spec and approve	20	03AUG09*	28AUG09		102		14,286.40						
445-2-110		Overload Protect-Design	40	31AUG09*	26OCT09		112		26,177.60						
445-2-115		Overload Protect-Fabr 4 chassis	65	27OCT09*	08FEB10		132		27,049.20						
445-2-120		Overload Protect-Test 4 units	10	09FEB10	22FEB10		132		10,758.40						
445-2-125		Overload Protect-Install & Rack wiring	20	23FEB10	22MAR10		132		20,532.55						
445-2-130		Overload Protect-Write & perform ISTP	15	23MAR10	12APR10		132		10,758.40						
445-2-135		Overload Protect-Documentation	180	31AUG09*	24MAY10		102		11,077.36						
445-2-140		Overload Protection&cabling design,procure instl	130	27OCT09*	10MAY10		112		61,328.23						
Subtotal			400	02FEB09	03SEP10		30		1,084,296.52						

EE//EM =40hr ; EE//SM =48hr ;
 EE//TB =120hr ; EA//SB =08hr ;
 EE//EM =24hr ; EE//SM =24hr ;
 EE//TB =32hr ;
 EE//EM =80hr ;
 EA//SB =32hr ; EE//EM =96hr ;
 EE//SM =32hr ;
 EE//EM =48hr ; EE//SM =120hr ;
 EE//EM =32hr ; EE//SM =32hr ;
 EE//EM =48hr ; EE//SM =77hr ;
 EE//EM =32hr ; EE//SM =32hr ;
 EA//SB =64hr ; EE//EM =16hr ;
 EE//EM =96hr ; EE//SM =45hr ;
 EE//TB =96hr ;
 41=13\$K ; EA//SB =80hr ;