

NCSX Work Approval Form (WAF)

WBS Number: 31

WBS Title: Magnetic Diagnostic Systems

Job Number: 3101

Job Title: Magnetic Diagnostic Systems

Job Manager: Brent Stratton

Description:

This effort covers the design, procurement of materials and parts, and fabrication and installation of the magnetic diagnostics for the NCSX machine. The magnetic sensors include diamagnetic loops, flux loops, saddle loops, Rogowski coils and B-coils that will provide signals to measure the magnetic flux change in the many geometries necessary to determine the magnetic field geometry using an equilibrium reconstruction code.

Schedule:

See Attached

Approvals:

_____	_____
Job Manager	Date
_____	_____
Responsible Line Manager	Date
_____	_____
Project Manager	Date
_____	_____
Engineering Department Head	Date

NCSX June 2007 ETC
TABLE II - Materials and Subcontracts

WBS Number: 31
WBS Title: Magnetic Diagnostic Systems
Job Number: 3101
Job Title: Magnetic Diagnostic Systems
Job Manager: Brent Stratton

Description	Material		Labor					
	Type	Cost \$	EMEM	EMSM	EMTB	EADM	EEEM	
Existing + Added Cost for Co Wound Loops for 18 TF and 6 PF and 2 SolenoidCoils								
Design Protective Boxes			110					TF Complete
Drawings			60					TF Complete.
Purchase SS Sheet		\$870	1					Partial.
Purchase Heat Shrink Tubing, 20 @ 100 ft		\$2,000	6					12 ordered in Dec 06 => 6 of 12 Received.
Purchase additional CoAxial cable 3500 ft		\$4,550	2					Placed order for 1900 ft
Prototype				12				TF Complete.
Formal Issue of Drawings Rev 0						0		Work Completed
Form 26 Protective Boxes				102				6 TF completed.
Weld end plates					18			6 TF completed.
Engineering Support Field/Fab Activities (Title III)			36					
Develop Convective Air Furnace		\$0		0				Work Completed
Fab TF, PF & solenoid co-wound loops				130				9 of 26 completed.
	TOTAL	\$7,420	215	244	18	0	0	
Existing + Added Cost for Flux Loop Junction Boxes and 20 Spacer Flux Loops and 6 Protective Boxes								
Purchase Material - 2.75 ConFlat Flanges		\$900	2					Based on previous experience
Purchase Material - AL and SS Plate		\$820			2			Based on previous experience
Purchase Material - 316 SS flat head screws		\$400			2			Based on previous experience
Purchase Material - Circuit Boards RF Filtered w/TB		\$3,200					32	Based on previous experience
Install 24 JB (410 cables) Act #								Included in Job 1810
Terminate 24 JB (410 cables)								Included in Job 1810
Anneal 2.75 Conflat Flanges				12				Based on previous experience
Engineering Support Field/Fab Activities (Title III)			120					Based on previous experience
Purchase 2000 ft 0.059 CoAx-Spacer		\$3,500	2					Based on previous experience
AutoCAD Drawings of Field Runs/Tag#/Port Assignments			112					Based on previous experience
Water Jet Machine Cu Templates		\$240			8			Based on previous experience
Install 20 Templates								Included in Job 1810
Install Spacer Flux Loops								Included in Job 1810
Twist leads								Included in Job 1810
Design Protect Box & Prepare Dwg			22					Based on previous experience
Fab 6 Prot Boxes		\$200		24				Based on previous experience
Install Prot Boxes								Included in Job 1810
Prepare Drawing of Spacer Loops						60		Based on previous experience
NOTE: M&S in Job 1204	TOTAL	\$9,260	258	36	12	60	32	

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Description	Material			Labor					
	Type	Cost \$	EMEM	EMSM	EMTB	EADM	EEEM		
Existing + Added Cost for High Temperature Rogowski Coil									
CDR + Peer Reviews			60						
Preliminary Design			60						
Fabricate Prototype		\$50			20				
Test Prototype		\$50		24					
Prepare for and Conduct PDR			20						
Final Design			60						
Purchase Spec for Winding Mandrel			40						
Trip to Vendor			16	16					
Sub contract Winding 3 Mandrels		\$15,000							
Prepare for and Conduct FDR			10						
Formal Issue of Drawings						4			
Purchase Material - ARI SS Coax Cable 0.032 inch		\$2,650	2						
Purchase Material - SS Flex and Bendable Smooth Tube		\$300	2						
Purchase Material - Nextel Tape		\$300	1						
Purchase Material - Inconel Bar		\$1,200	2						
Fabricate coil clamps - 36 (3 Field Periods 12 ea)						90			
Fabricate ends			4	32					
Fixture to Straighten Smooth SS Tube		\$30	4			32			
Install Wound Coil into Protective SS Flex		\$50							
Install 3 Rogowski Coils									Included in Job 1810
Weld 36 coil clamps									Included in Job 1810
Engineering Support Field/Fab Activities (Title III)			60						Included in Job 1810
TOTAL		19,630	281	72	142	4		0	

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Description	Material			Labor						
	Type	Cost \$	EMEM	EMSM	EMTB	EADM	EEEM			
Added Cost for Voltage Loops and Protective Boxes										
Drawings- Engineering Sketch of Routing			20							Based on previous experience
Drawings- Layout							16			Based on previous experience
Formal Release of Layout Drawing							4			Based on previous experience
Protective Box Design			6							Based on previous experience
Protective Box Drawing			20							Based on previous experience
Install Voltage 12 Loops on VV										Included in Job 1810
Twisted leads to Prot. Boxes										Included in Job 1810
Fab 3 Protective Boxes	316 SS by 0.048 Thk	\$120				12				Based on previous experience
Install 3 Protect. Boxes										Included in Job 1810
Engineering Support Field/Fab Activities (Title III)			6							Based on previous experience
Purchase additional 900 ft cable	0.059 OD Inconel CoAx	\$1,600	2							
	TOTAL	\$1,720	54	0	12	20	0			
	Total	\$28,770	550	316	172	24	0			

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TABLE IV - Uncertainty of Estimate and Residual Risk Assessment

WBS Number: 31
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Uncertainty of the Estimate

	<u>High</u>	<u>Medium</u>	<u>Low</u>	<u>Uncertainty Range (%)</u>	<u>Comments/Other Considerations</u>
Design Maturity	X			-5%/+10%	Exception is Rogowski => Medium - design not finalized
Design Complexity			X		Exception is Rogowski => Medium - design not finalized

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		Schedule Impact	
					Low	High	Low	High
High temperature Rogowski Loop damaged during installation resulting in loss of toroidal current measurement capability		5%	Triple redundancy	3 Installed - only one required.	+\$0K	+\$0K	+0.00	+0.00

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=Unlikley (40%>P>10%), VU=Very Unlikley (P<10%), NC=Non-credible (P<1%)

Activity ID	MILE-stones (level 2 & 3)	Activity Description	Duration (work days)	Baseline Start	Baseline Finish	Shifts	Total Float	% cmplt	Proposed Budgeted							
										FY07	FY08	FY09	FY10	FY11	FY12	
31 - Magnetic Diagnostics																
Job: 3101 - Magnetic Diagnostics-STRATTON																
Modular Coil C-wound Loops																
3101-229		Fabricate(12) MC Protective boxes (completed)	43	01MAY07A	01MAY07A				0.00							
Rogowski Coils																
3101-316		CONCEP DESIGN ROWGOWSKI COIL	30	01MAY07*	12JUN07			188	9,049.20	EM/EM =60hr ;						
3101-317		PRELIM DESIGN ROWGOWSKI COIL incl prototype	30	13JUN07*	25JUL07			188	16,670.28	em//em=80;em//sm=242;em//tb=20;41=0.1k						
3101-318		PDR - ROWGOWSKI COIL	0		25JUL07*			188	0.00	EM/EM =126hr ;em//sm=16;ea/sb=4						
3101-325		FINAL DESIGN ROWGOSKI COIL	30	26JUL07*	06SEP07			188	21,435.88	41=15k						
3101-340		subcontract winding 3 mandrels	30	26JUL07*	06SEP07			188	19,140.00							
3101-326	3	FDR - ROWGOSKI COIL	0		06SEP07			188	0.00	41=4.5\$K ; EM//EM =15hr ; EM//SM =32hr ; EM//TB =122hr ;						
3101-329		FAB ROWGOWSKI COILS incl clamps	45	07SEP07	08NOV07			188	21,886.09	EM/EM =60						
3101-330		Title III	45	07SEP07	08NOV07			188	9,434.71	LOE						
TF and PF Co-wound Loops																
3101-425		Design Protective boxes for PF	20	01OCT07*	26OCT07			242	24,881.50	EA/SB =60hr ; EM//EM =110hr ;						
3101-426		Purchase SS Sheet	15	29OCT07*	16NOV07			242	1,218.07	EM//TB =1; 41=0.87k						
3101-452		Form Protective boxes	20	19NOV07	18DEC07			242	13,475.22	em//sm=102						
3101-454		Weld end plates of PF protective boxes	10	19DEC07	10JAN08			242	1,441.98	em//tb=18						
3101-427		Purchase Heat Shrink tubing	15	04SEP07*	24SEP07			286	3,002.90	EM//TB =6; 41=2.0k						
3101-428		Purchase aad'I CoAxial cable	40	04SEP07*	29OCT07			261	5,973.11	EM//TB =2hr ; 41=4.5\$K ;						
3101-450		Prototype PF Loops	10	30OCT07*	12NOV07			261	1,585.32	em//sm=12						
3101-458		FabTF,PF & solenoid co-wound loops	40	13NOV07	18JAN08			261	17,174.30	em//sm=130						
3101-456		Title III	70	29OCT07	14FEB08			242	5,788.44	em//em=36						
T/C and Heater Tape Leads																
1204-140		Design T/C and Heater Tape Leads	20	01AUG07*	28AUG07			116	20,511.52	EM/EM =136						
1204-140.2		Design Drafting T/C and Heater Tape Leads	20	01AUG07*	28AUG07			126	3,373.80	ea//sb=30						
1204-140.1		Peer Review T/C and Heater Tape Leads	5	08AUG07	14AUG07			126	4,524.60	EM/EM =30						
1204-141		Drawings Signed T/C and Heater Tape Leads	0		28AUG07			116	0.00							
1204-146		Procurement support T/C and Heater Tape Leads	20	29AUG07	26SEP07			116	6,032.80	EM/EM =40						
1204-147		Field/Fab support (title III) T/C&Heater Tape	65	27SEP07	08JAN08			116	4,012.08	EM/EM =25						
1204-148		Machine 12 2.75 cf blanks	20	29AUG07	26SEP07			181	4,461.12	em//sm=36						
1204-150		Rubber seal	20	29AUG07	26SEP07			181	0.00							
1204-151		Machine 6 commercial aluminum boxes	20	29AUG07	26SEP07			181	4,461.12	em//sm=36						
Flux loop junction boxes and spacer templates																
1204-160		Design Protective Boxes	10	01MAY07	14MAY07			187	3,318.04	EM/EM =22						

Run Date 18JUL07 07:31

ETCZ

NCSX Project
Resource Loaded Schedule
EAC

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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
1204-165		Issue req,Bid & Award- Flux Loop Junction Boxes	25	15MAY07	19JUN07		187		0.00						
1204-170		Autocad dwgs of field runs/tag#/ports assignmt	10	01AUG07*	14AUG07		193		16,891.84						
1204-161		Fab Protective Boxes	10	09AUG07	22AUG07		187		5,623.76						
1204-171		Prep Dwgs of spacer loops	10	01AUG07*	14AUG07		593		6,747.60						
1204-172		Title III	96	15MAY07	28SEP07		1,249	LOE	18,098.40						
1204-173		Purchase material for boxes&spacers (in job 1204	35	20JUN07	08AUG07		187		6,111.88						
Voltage Loops & Protective Boxes															
3101-800		Design Routing and Boxes	20	01OCT07*	26OCT07		239		9,794.54						
3101-802		Fab 3 protective Boxes	10	29OCT07	09NOV07		249		1,118.28						
3101-804		Purchase 900ft cable	20	29OCT07*	23NOV07		239		2,414.38						
3101-806		Title III	20	29OCT07	23NOV07		239	LOE	964.74						
Subtotal			0		14FEB08		1,159		290,617.50						

EM//em=112
EM//SM=36; 41=0.44k; em//tb=8
ea//sb=60
EM//em=120
ee//em=32;em//em=4;em//tb=4
em//em=46;ea//sb=20
41=0.12k; em//tb=12
41=1.6k;em//em=2
em//em=6