

NCSX Fabrication Project Cost and Schedule Estimating Form

WBS 131 TF Coils

Labor

Activity Title	Manhours	FY2003 \$\$	Labor Type	Start Date Month/Yr	End Date Month/Yr	Comments
Preliminary Design (Title I)						
(50% of design schedule)	275		<i>EAEM</i>	Oct-03	Feb-04	PPPL Engineer
	290		<i>EADM</i>	Oct-03	Feb-04	PPPL Designer
	73		<i>ORNL Eng</i>	Oct-03	Feb-04	Composite of ORNL Engineer / Designer
	0		<i>ORNL Phys.</i>	Oct-03	Feb-04	Composite of ORNL Physics / scientific
	0		<i>PPPL Phys.</i>	Oct-03	Feb-04	PPPL Physics/scientific
Final Design (Title II)						
(50% of design schedule)	275		<i>EAEM</i>	Feb-04	Jul-04	PPPL Engineer
	290		<i>EADM</i>	Feb-04	Jul-04	PPPL Designer
	73		<i>ORNL Eng</i>	Feb-04	Jul-04	Composite of ORNL Engineer / Designer
	0		<i>ORNL Phys.</i>	Feb-04	Jul-04	Composite of ORNL Physicist
	0		<i>PPPL Phys.</i>	Feb-04	Jul-04	PPPL Physics/scientific
Lab R&D labor						
	0		<i>EAEM</i>	Oct-03	Feb-04	PPPL Engineer
	0		<i>EADM</i>	Oct-03	Feb-04	PPPL Designer
	0		<i>ORNL Eng</i>	Oct-03	Feb-04	Composite of ORNL Engineer / Designer
	0		<i>EASM</i>	Oct-03	Feb-04	PPPL monthly support
	0		<i>EMTB</i>	Oct-03	Feb-04	PPPL Technician
Lab Fab/Assembly/Installation (Title III)						
	666		<i>EAEM</i>	Jul-04	Jan-06	PPPL Engineer
	96		<i>EADM</i>	Jul-04	Jan-06	PPPL Designer
	62		<i>ORNL Eng</i>	Jul-04	Jan-06	Composite of ORNL Engineer / Designer
	0		<i>EASM</i>	Jul-04	Jan-06	PPPL monthly support
	0		<i>EMTB</i>	Jul-04	Jan-06	PPPL Technician

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Labor

Manhours per fiscal year by labor category

Level of Effort		FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	TOTAL
PPPL Engineer	<i>EAEM</i>	0	659	445	112	0	0	1216
PPPL Designer	<i>EADM</i>	0	596	64	16	0	0	676
Composite of ORNL Engineer / Designer	<i>ORNL Eng</i>	0	155	42	11	0	0	208
PPPL monthly support	<i>EASM</i>	0	0	0	0	0	0	0
PPPL Technician	<i>EMTB</i>	0	0	0	0	0	0	0
Composite of ORNL Physics / scientific	<i>ORNL Phy</i>	0	0	0	0	0	0	0
PPPL Physics/scientific	<i>PPPL Phy</i>	0	0	0	0	0	0	0

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M&S Costs

Activity Title	FY2003 \$\$	Comment
Manufacturing Development (R&D)		
Purchased Design Services	\$0	
Procured Hardware/Material	\$0	
Profit	\$0	included in hardware estimate
<i>total, manf/dev (R&D)</i>	\$0	w/o G&A
Procured Hardware/Material		
set of 18 TF coils	\$956,362	
Profit	<u>\$95,636</u>	assume 10%
<i>total, procured hdwe/matl.</i>	\$1,051,998	w/o G&A
Purchased Design Services	\$0	no purchased services anticipated
Procured Installation/Assembly Costs	\$0	All installation and assembly costs are included in WBS 7

Other Costs

Activity Title	FY2003 \$\$	Comment
Travel	\$2,000	only two trips are anticipated

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Summary Costs

Activity Title	Manhours	FY2003 \$\$	Comment
Labor			
PPPL Effort	1,892	\$253,709	<i>Assumed rates:</i> <i>EAEM</i> 153 \$/hr <i>EADM</i> 100 \$/hr <i>ORNL Eng</i> 130 \$/hr <i>EASM</i> 100 \$/hr <i>EMTB</i> 73 \$/hr PPPL Phys 141 \$/hr ORNL Phys 160 \$/hr
ORNL effort	208	\$26,988	
subtotal, labor	2,100	\$280,697	
M&S, Other			
Manufacturing Development (R&D)		\$0	
Procured Hardware/Material		\$1,051,998	
Purchased Design Services		\$0	
Procured Installation/Assembly Costs		\$0	
Travel		\$2,000	
subtotal, M&S		\$1,053,998	
G&A		\$149,409	25% on all purchased materials, subcontracts, travel \$114,090 G&A adjustment on large procurement
Subtotal without contingency		\$1,484,104	
Contingency		\$356,185	24% Overall on this WBS
Total cost		\$1,840,289	

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WBS 131 TF Coils

In-house Fabrication and Assembly

Description:

No fabrication and assembly is associated with this WBS

Labor category

	multiplier	unit	no.	hours	total fraction	EAEM fract.	hrs	EASM, EMSM fract.	hrs	EMTB fract.	hrs	EADM fract.	hrs
Fab operations summary													
	0	hrs/lot	1	0	1.00	0.00	0	0.00	0	0.00	0	1.00	0
	0	hrs/line	1	0	0.00	0.00	0	0.00	0	0.00	0	0.00	0
	0	hrs / coil	1	0	0.00	0.00	0	0.00	0	0.00	0	0.00	0
<i>subtotal</i>				0			0		0		0		0
Assembly operations summary													
	0	hr/lot	1	0	1.00	0.00	0	1.00	0	0.00	0	0.00	0
	0	hr/lot	1	0	0.00	0.00	0	0.00	0	0.00	0	0.00	0
	0	hr/coil	1	0	0.00	0.00	0	0.00	0	0.00	0	0.00	0
	0	hours	1	0	0.00	0.00	0	0.00	0	0.00	0	0.00	0
<i>subtotal</i>				0			0		0		0		0

WBS 131 TF Coils

Materials and Subcontracts (M&S)

Description:
This effort covers procurement of the TF coil windings. The coils are procured via a fixed price contract and include the winding assembly with terminal blocks for attachment of leads.

Purchased parts:

TF Coil windings	\$956,362	see notes below
subtotal purchased parts	\$956,362	
outside engr rate =	130	\$ per hour
outside lab rate =	60.0	\$ per hour
outside inspection/technician rate =	80.0	\$ per hour

Worksheet:

TF Winding geometry

Length_m	8.7	average perimeter per turn
NumberCoils	18	
TurnsHigh	6	
TurnsWide	2	
Turns	12	
ConductorLengthPerCoil_m	103.9	
EnvelopeHeight_mm	88.0	
EnvelopeWidth_mm	86.0	
BundleHeight_mm	84.9	
BundleWidth_mm	100.8	
BundleArea_sqm2	8559.8	
BundleArea_sqm2	10.0	
BundleArea_sqm2	0.1	
GroundWdgmm	0.8	
TurnInsulation_mm	1.3	
PlasCableInsulation_mm	10.0	
ConductorHeight_mm	11.4	
ConductorWidth_mm	48.1	
CornerRadius_mm	2.5	
CornerArea_sqm2	5.4	
CoolingInletWidth_mm	6.8	
cooling hole height mm	19.3	
CoolingArea_sqm2	121.2	
ConductorArea_sqm2	419.9	
PIFFactor	1.0	
CopperArea_sqm2	419.9	
copper density_kghmm ³	8.98E-06	
Weightcoil_kg	3.74E+02	

TF Winding cost details

Ref: P. Heitzmroeder

I. Tooling by vendor

Tooling engineering/mtg. Plans	hrs.	240	
Tooling engineering	\$	31200	
Tooling design	hrs.	240	
Tooling fabrication (200% of 1 coil mat)	\$	19200	
Tooling for Nose manufacturing	\$	20647	
Tooling for Nose	hrs.	0.00	incl in tooling design
Tooling for nose	\$	4000.00	
Total tooling design hours	hrs.	480	(half engineer, half designer)
Total tooling cost	\$	116947	

II. Materials

Q-resin/epoxy materials	hrs.	500	technician hours
copper extrusion cost	\$	49000	
Cooper order factor	1.25	factor	assume 25% overage
copper cost: 18 coils	\$	84714	
misc mat: \$ per lb of Cu in coils	2.0	\$/kg	
misc mat: Cost: cost of coils	\$	13474	
alase insul width	mm	7.5	
turn insul: length/meter of cond.fayer	mm	4.68	
turn ins: Tape Thickness	mm	0.18	
No. half spaced layers	#	2	
meters of ins. roll	m	10.00	
no. rolls/coil	#	97.3	
insulation waste factor	multiplier	1.1	
total rolls of turn ins. reqd.	#	2277.2	
turn insulation cost per roll	\$/roll	40	
total rolls of turn ins. reqd.	mm	25	
Radon insul width	mm	4.68	
turn insul: length/meter of cond.fayer	mm	0.27	
turn ins: Tape Thickness	mm	1	
No. half spacedRadon layers	#	1	
meters of ins. roll	m	10.00	
no. rolls/coil	#	48.7	
insulation waste factor	multiplier	1.3	
total rolls of turn ins. reqd.	#	1138.6	
turn insulation cost per roll	\$/roll	40	
turn insulation total cost: 18 coils	\$	84653	
ground wall tape thickness	mm	0.38	
No. half spaced layers	#	2.00	
total around wall thick.	mm	1.52	
around wall tape width	cm	6	
dw tape length reqd.	m	214	
meters of ins. roll	m	10	
no. rolls/coil	#	71	
insulation waste factor	multiplier	1.30	
no. rolls of GW insulation: 18 coils	#	502	
GW tape cost per roll	\$	50	
GW insulation cost: 18 coils	\$	25081	
Epoxy volume reqd.: (15% void fraction)	l	11	
Epoxy cost/ltr	\$/l	70	
Epoxy cost for 18 coils	\$	7703	
Leads and coolant connections/coil	\$	3000	
Leads & coolant con's: all coils	\$	54000	
II. Material cost for 18 coils	\$	239325	M&S w/o GLA

III. Labor

Tooling prep.	shifts	1	
turns/hr. shift: incl. insulation application	#	4	
crew size	#	3	
Shifts reqd. per coil	hrs.	30	
person-hours to prep & wind coil	hrs.	64	half time for all shifts
technical oversight/coil	\$	8309	
tech. Oversight cost	\$	12	
GW application time-rolls/shift	#	2	
crew size for GW	hrs.	37	
person hours to apply	hrs.	24	
VPI crew & process: 1747 m-coil	#	7	
crew size for VPI	hrs.	258	
person financial for VPI	hrs.	16	
elec/hydraulic test	hrs.	4137	technician laborer
Total labor hours for 18 coils	\$	640490	
III.Total Labor Cost	\$	640490	

Total Manufacturing Costs, TF Coils \$ 963362

NCSX Fabrication Project Cost and Schedule

WBS 131 TF Coils

Engineering, Title I, II and III

Description:

This effort covers all Title I, II, and III engineering for the TF coil windings. The coils are procured via a fixed price contract. All installation oversight will be performed as part of WBS 7.

	multiplier	unit	no.	hours	Labor category											
					total		EAEM		EADM		ORNL Eng		ORNL Physics		PPPL Physics	
					fraction	hrs	fract.	hrs	fract.	hrs	fract.	hrs	fract.	hrs	fract.	hrs
Title I, II design																
Pro-E models (avg)	40	hrs/model	5	200	1.00	0.25	50	0.50	100	0.25	50	0.00	0	0.00	0	
assy dwgs	40	hrs/dwg	4	160	1.00	0.00	0	1.00	160	0.00	0	0.00	0	0.00	0	
Detail drawings	40	hrs/dwg	6	240	1.00	0.00	0	1.00	240	0.00	0	0.00	0	0.00	0	
installation dwg	40	hrs/dwg	1	40	1.00	0.00	0	1.00	40	0.00	0	0.00	0	0.00	0	
cooling schematic	20	hrs/dwg	1	20	1.00	0.00	0	1.00	20	0.00	0	0.00	0	0.00	0	
electrical schematic	20	hrs/dwg	1	20	1.00	0.00	0	1.00	20	0.00	0	0.00	0	0.00	0	
I&C schematic	20	hrs/dwg	0	0	1.00	0.00	0	1.00	0	0.00	0	0.00	0	0.00	0	
stress analysis	40	hrs/calc	2	80	1.00	1.00	80	0.00	0	0.00	0	0.00	0	0.00	0	
thermal analysis	40	hrs/calc	2	80	1.00	1.00	80	0.00	0	0.00	0	0.00	0	0.00	0	
special analysis (electromagnetics)	80	hrs/calc	1	80	1.00	0.50	40	0.00	0	0.50	40	0.00	0	0.00	0	
procurement/fab specifications	80	hrs/spec	1	80	1.00	1.00	80	0.00	0	0.00	0	0.00	0	0.00	0	
preliminary and final design reviews	80	hrs/rev	2	160	1.00	0.80	128	0.00	0	0.20	32	0.00	0	0.00	0	
meetings/reporting/presentations	10%	% of tot	1160	116	1.00	0.80	93	0.00	0	0.20	23	0.00	0	0.00	0	
<i>subtotal</i>				1276			551		580		145		0		0	
Title III																
vendor oversight, inspection	8	hrs/wk	52	416	1.00	1.00	416	0.00	0	0.00	0	0.00	0			
Disposition of deviation requests and non-conformances	4	hrs/wk	78	312	1.00	0.80	250	0.00	0	0.00	0	0.20	62			
As-built drawings	8	hrs/dwg	12	96	1.00	0.00	0	0.00	0	1.00	96	0.00	0			
<i>subtotal</i>				824			666		0		96		62			

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Engineering, Title I, II and III

Schedule assumptions	start	duration (weeks)	end
Title I Design	Oct-03	18	Feb-04
Title II Design	Feb-04	18	Jul-04
Procurement	Jul-04	52	Jul-05
In-house fab / sub-assy	Jul-05	0	Jul-05
Installation / final assembly	Jul-05	26	Jan-06

Notes and worksheets

TF Coil winding design

	total	Windings	Crossovers and lead blocks	
Pro-E models	5	2	3	
assy dwgs	4	2	2	double pancake, crossover/lead area, overall assy
Detail drawings	6	2	4	winding, lead blocks, crossover fillers
installation dwg	1	1	0	
cooling schematic	1	1		
electrical schematic	1	1		
I&C schematic	0			covered in WBS 133
stress analysis	2	1	1	global and local analysis of winding pack and lead regions
thermal analysis	2	1	1	global and local analysis of winding pack and lead regions
special analysis	1			em analysis of lead area, general analysis in WBS 171
procurement specifications	1			one procurement specification for winding
preliminary and final design reviews	2			reviews
meetings/reporting/presentations	15%			