WBS 186 Tooling Design and Fabrication

Labor

Activity Title	Manhours	FY2003 $$	Labor Type	Start Date Month/Yr	End Date Month/Yr	Comments
Preliminary Design (Title I)						
(50% of design schedule)	120		*EAEM*	Apr-03	Nov-03	PPPL Engineer
	0		*EADM*	Apr-03	Nov-03	PPPL Designer
	1370		*ORNL Eng*	Apr-03	Nov-03	Composite of ORNL Engineer / Designer
	60		*ORNL Phys.*	Apr-03	Nov-03	Composite of ORNL Physics / scientific
	0		*PPPL Phys.*	Apr-03	Nov-03	PPPL Physics/scientific
Final Design (Title II)						
(50% of design schedule)	120		*EAEM*	Nov-03	Jun-04	PPPL Engineer
	0		*EADM*	Nov-03	Jun-04	PPPL Designer
	1363		*ORNL Eng*	Nov-03	Jun-04	Composite of ORNL Engineer / Designer
	60		*ORNL Phys.*	Nov-03	Jun-04	Composite of ORNL Physicist
	0		*PPPL Phys.*	Nov-03	Jun-04	PPPL Physics/scientific
Lab R&D labor						
	160		*EAEM*	Apr-03	Nov-03	PPPL Engineer
	0		*EADM*	Apr-03	Nov-03	PPPL Designer
	259		*ORNL Eng*	Apr-03	Nov-03	Composite of ORNL Engineer / Designer
	72		*EASM*	Apr-03	Nov-03	PPPL monthly support
	168		*EMTB*	Apr-03	Nov-03	PPPL Technician
Lab Fab/Assembly/Installation (Title III)						
	126		*EAEM*	Jul-04	Oct-06	PPPL Engineer
	0		*EADM*	Jul-04	Oct-06	PPPL Designer
	446		*ORNL Eng*	Jul-04	Oct-06	Composite of ORNL Engineer / Designer
	494		*EASM*	Jul-04	Oct-06	PPPL monthly support
	1344		*EMTB*	Jul-04	Oct-06	PPPL Technician

WBS 186 Tooling Design and Fabrication

Labor

Manhours per fiscal year by labor category

Level of Effort		FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	TOTAL
PPPL Engineer	*EAEM*	240	174	56	56	0	0	*526*
PPPL Designer	*EADM*	0	0	0	0	0	0	*0*
Composite of ORNL Engineer / Designer	*ORNL Eng*	1393	1649	198	198	0	0	*3438*
PPPL monthly support	*EASM*	62	66	219	219	0	0	*566*
PPPL Technician	*EMTB*	144	175	597	597	0	0	*1512*
Composite of ORNL Physics / scientific	*ORNL Phy*	51	69	0	0	0	0	*120*
PPPL Physics/scientific	*PPPL Phy*	0	0	0	0	0	0	*0*

WBS 186 Tooling Design and Fabrication

M&S Costs

Activity Title	FY2003 $$	Comment
Manufacturing Development (R&D)		
Purchased Design Services	$0	
Procured Hardware/Material	$124,000	
Profit	$0	profit already included in these items
total, manf/dev (R&D)	$124,000	w/o G&A
Procured Hardware/Material		
Tooling assy fixtures, misc. equipment	$261,500	
General procurements	$20,000	
Welding tools, materials and equipment	$25,000	
Welding tools, materials and equipment	$20,000	
Profit at 10%	$32,650	
total, procured hdwe/matl.	$359,150	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	$10,000	one trip per major fixture

WBS 186 Tooling Design and Fabrication

Summary Costs

Activity Title	Manhours	FY2003 $$	Comment
Labor			
PPPL Effort	2,604	$247,469	*Assumed rates:* *EASM* 100 $/hr
ORNL effort	3,558	$466,192	*EAEM* 153 $/hr *EMTB* 73 $/hr
subtotal, labor	6,162	$713,661	*EADM* 100 $/hr PPPL Phys 141 $/hr
			ORNL Eng 130 $/hr ORNL Phys 160 $/hr
M&S, Other			
Manufacturing Development (R&D)		$124,000	
Procured Hardware/Material		$359,150	
Purchased Design Services		$0	
Procured Installation/Assembly Costs		$0	
Travel		$10,000	
subtotal, M&S		$493,150	
G&A		$123,288	25% on all purchased materials, subcontracts, travel
Subtotal without contingency		$1,330,099	
Contingency		$532,039	40% Overall on this WBS
Total cost		$1,862,138	

WBS 186 Tooling Design and Fabrication

In-house Fabrication and Assembly

Description:
This effort covers all PPPL effort involved with preparing the facility space for field period assembly. There is very little area prep to do after the test cell is made ready for coil winding.

Labor category

	multiplier	unit	no.	hours	total fraction	EAEM fract.	EAEM hrs	EASM, EMSM fract.	EASM, EMSM hrs	EMTB fract.	EMTB hrs	EADM fract.	EADM hrs
Sub-assembly													
Installation of VV fixtures	80	ea	3	240	1.00	0.00	0	0.20	48	0.80	192	0.00	0
installation of mod coil fixtures	80	ea	2	160	1.00	0.00	0	0.20	32	0.80	128	0.00	0
installation of TF coil fixtures	80	ea	1	80	1.00	0.00	0	0.20	16	0.80	64	0.00	0
misc fab/assembly on site	1200		1	1200	1.00	0.00	0	0.20	240	0.80	960	0.00	0
				0	1.00	0.00	0	1.00	0	0.00	0	0.00	0
				0	1.00	0.00	0	0.00	0	1.00	0	0.00	0
subtotal				*1680*			*0*		*336*		*1344*		*0*

					total fraction	EAEM fract.	EAEM hrs	EASM, EMSM fract.	EASM, EMSM hrs	EMTB fract.	EMTB hrs	EADM fract.	EADM hrs
				0	1.00	0.00	0	1.00	0	0.00	0	0.00	0
				0	1.00	0.00	0	0.00	0	1.00	0	0.00	0
				0	1.00	0.00	0	1.00	0	0.00	0	0.00	0
				0	1.00	0.00	0	0.00	0	1.00	0	0.00	0
				0	1.00	0.00	0	1.00	0	0.00	0	0.00	0
subtotal				*0*			*0*		*0*		*0*		*0*

Schedule assumptions	**start**	**duration (weeks)**	**end**
Title I Design, R&D	Aug-03	10	Sep-03
Title II Design	Oct-03	26	Apr-04
Procurement	Apr-04	22	Oct-04
In-house fab / sub-assy	Oct-04	48	Sep-05
Installation / final assembly	Feb-05	67	Jun-06

Notes and worksheets

Field Period Assembly Area Preparation

Ref J. Chrzanowski spreadsheet, April 2003

This proposal includes the costs associated with the fabrication of (18) Modular coils for the NCSX Machine.
This includes inspection of the conductor and castings, coil winding, VPI and Testing activities.

ctivity		Duration	Start	End	HP	Safety	IH	QC	EAEM	EADM	EMSM	EMSM	EMTB	M&S	M&S
	Activity Description								Engr	Designer	Sr. Lab	machinist	Tech		
ID		Days			hours	hours	hours	hours	hours	hours	hours	hours	hours	w/o G&A	w/G&A
	Notes: A number of activities can be performed in parallel and are not series activities during the field period assemblies. a) The TF coil sub-assembly b) The sub-assembly of the modular coils c) Preparation of the vacuum vessel for assembly														
##	**Tooling Design and Fabrication**														
	1) Task involves the design, fabrication and procurement of tooling and equipment to assemble the field period assemblies														
	2) Fixtures include: a) (2) Mod. Coil sub assy. Stands b) (2) TF coil stands c) (3) VV stands d) (1) Mod. Coil assy fixture														
	Final tooling design	165	3-Oct-03	1-Jun-04	Cost in Engr				432	1000					
	Lab fabrication/assy./installation	273	2-Jun-04	30-Jun-05					30			400	1728		
	Tooling assy fixtures, misc. equipment	273	2-Jun-04	30-Jun-05	Cost in M&S										
	General procurements	439	1-Oct-04	30-Jun-06	Cost in M&S										
	Welding tools, materials and equipment	252	2-Jun-04	30-Sep-06	Cost in M&S										
					0	0	0	0	462	1000	0	400	1728	0	

WBS 186 Tooling Design and Fabrication

Materials and Subcontracts (M&S)

Description:
This effort covers all M&S required for Field Period Assembly Planning and Oversight

Assumptions:

outside engr rate =	120	$ per hour
outside fab rate =	60	$ per hour
outside inspection/technician rate =	80	$ per hour

Purchased parts:

subtotal, purchased parts	**$0**

Purchased materials for in-house fabrication and sub-assembly

Tooling assy fixtures, misc. equipment	$261,500
General procurements	$20,000
Welding tools, materials and equipment	$25,000
subtotal purchased materials	**$306,500**

Worksheet:

Tooling assy fixtures, misc. equipment

	unit cost	unit	no.	total	remarks
VV supporting fixture	$25,000	ea	3	$75,000	supports vv segment
modular coil 3-coil sub-assy frame	$8,000	ea	2	$16,000	assembles three coils into sub assembly
modular coil 3-coil sub-assy manipulator	$100,000	ea	1	$100,000	6 axis controlled motion
modular coil temporary support fixtures	$15,000	ea	3	$45,000	jacks and frames for supporting mod coils
TF coil sub-assembly frame	$8,000	ea	1	$8,000	TBD
TF coil 3-coil assembly manipulator	$0	ea	0	$0	use crane
full field period support fixture	$2,500	lot	3	$7,500	blocks from floor to TF structure
VV port welding fixtures	$10,000	lot	1	$10,000	clamps and supports to position port extensions
subtotal				**$261,500**	

General procurements

slings, swivels, chain-falls, etc.	$10,000	lot	1	$10,000	
Leak check bags, tape, hoses, etc.	$5,000	lot	1	$5,000	
Mass Spec leak detector	$0	ea	1	$0	on hand
vacuum pumps	$0	ea	1	$0	on hand
bakeout lines	$5,000	lot	1	$5,000	
subtotal				**$20,000**	

Welding tools, materials and equipment

Narrow gap TIG welding tools	$7,500	ea	2	$15,000	
welding consumables	$10,000	lot	1	$10,000	
subtotal				**$25,000**	

WBS 186 Tooling Design and Fabrication

R&D

Description:
Full Scale and partial scale mockups of coils and vacuum vessel are needed to practice various assembly and handling operations

Summary

Purchased Design Services

subtotal	$0	w/o G&A

Procured Hardware/Material

mockups	$124,000	
subtotal	$124,000	w/o G&A

Subcontractor labor rates:

design rate:	$120 per hour
fab rate	$60 per hour
inspection/technician rate	$80 per hour

						Labor category									
R&D design					total	EAEM		EADM		ORNL Eng		EASM		Vendor	
Task		**unit**	**no.**	**hours**	fraction	fract.	hrs	fract.	hrs	fract.	hrs	fract.	hrs	fract.	hrs
Pro-E models	20	hrs/model	5	100	1.00	0.00	0	0.00	0	1.00	100	0.00	0	0.00	0
assy dwgs	20	hrs/dwg	1	20	1.00	0.00	0	0.00	0	1.00	20	0.00	0	0.00	0
Detail drawings	8	hrs/dwg	2	16	1.00	0.00	0	0.00	0	1.00	16	0.00	0	0.00	0
installation dwg	0	hrs/dwg	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0
cooling schematic	0	hrs/dwg	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0
electrical schematic	0	hrs/dwg	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0
I&C schematic	0	hrs/dwg	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0
special analysis	0	hrs/calc	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0
procurement specifications	40	hrs/spec	2	80	1.00	0.00	0	0.00	0	1.00	80	0.00	0	0.00	0
vendor shop drawings	0	hrs/dwg	0	0	1.00									1.00	0
vendor part programming	0	hrs/model	0	0	1.00									1.00	0
vendor misc engineering	0%	% of tot	0	0	1.00									1.00	0
preliminary and final design reviews	40	hrs/rev	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0
meetings/reporting/presentations	20%	% of tot	216	43	1.00	0.00	0	0.00	0	1.00	43	0.00	0	0.00	0
subtotal				*259*			*0*		*0*		*259*		*0*		*0*

					total	EAEM		EADM		ORNL Eng		EASM, EMSM		EMTB	
R&D Tasks and Title III (see notes)					fraction	fract.	hrs	fract.	hrs	fract.	hrs	fract.	hrs	fract.	hrs
tech setup and practice (3@2weeks)	240	hrs	1	240	1.00	0.00	0	0.00	0	0.00	0	0.30	72	0.70	168
engr oversight	80	hrs	1	80	1.00	1.00	80	0.00	0	0.00	0	0.00	0	0.00	0
metrology practice	80	hrs	1	80	1.00	1.00	80	0.00	0	0.00	0	0.00	0	0.00	0
	0		1	0	0.00	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
	0		1	0	0.00	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
subtotal				*400*			*160*		*0*		*0*		*72*		*168*

Schedule assumptions	**start**	**duration (weeks)**	**end**
R&D planning	Nov-02	4	Dec-02
Bid and award	Dec-02	2	Dec-02
R&D procurement / in-house fab.	Dec-02	4	Jan-03
R&D testing	Jan-03	52	Jan-04

Notes and worksheets

Engineering Design

Pro-E models	5
assy dwgs	1
Detail drawings	2
installation dwg	0
cooling schematic	0
electrical schematic	0
I&C schematic	0
special analysis	0
procurement specifications	2
Epoxy R&D contract	0
Tooling and fixtures	0
Clean room	0
Cable conductor	0
vendor shop drawings	0
vendor part programming	0
vendor misc engineering	0
preliminary and final design reviews	0
meetings/reporting/presentations	10%

WBS 186 Tooling Design and Fabrication

Engineering, Title I, II and III

Description:
This effort covers all Title I, II, and III engineering for the field period subassembly tooling and fixtures

						Labor category									
					total fraction	EAEM		EADM		ORNL Eng		ORNL Physics		PPPL Physics	
	multiplier	unit	no.	hours		fract.	hrs	fract.	hrs	fract.	hrs	fract.	hrs	fract.	hrs
Title I, II design															
Pro-E models (avg)	16	hrs/model	40	640	1.00	0.00	0	0.00	0	1.00	640	0.00	0	0.00	0
assy dwgs	20	hrs/dwg	20	400	1.00	0.00	0	0.00	0	1.00	400	0.00	0	0.00	0
Detail drawings	20	hrs/dwg	42	840	1.00	0.00	0	0.00	0	1.00	840	0.00	0	0.00	0
installation dwg	20	hrs/dwg	9	180	1.00	0.00	0	0.00	0	1.00	180	0.00	0	0.00	0
cooling schematic	20	hrs/dwg	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0
electrical schematic	20	hrs/dwg	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0
I&C schematic	20	hrs/dwg	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0
stress analysis	24	hrs/calc	8	192	1.00	0.00	0	0.00	0	1.00	192	0.00	0	0.00	0
thermal analysis	40	hrs/calc	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0
special analysis (electromagnetics)	40	hrs/calc	3	120	1.00	0.00	0	0.00	0	0.00	0	1.00	120	0.00	0
procurement/fab specifications	40	hrs/spec	8	320	1.00	0.75	240	0.00	0	0.25	80	0.00	0	0.00	0
preliminary and final design reviews	40	hrs/rev	3	120	1.00	0.00	0	0.00	0	1.00	120	0.00	0	0.00	0
meetings/reporting/presentations	10%	% of tot	2812	281	1.00	0.00	0	0.00	0	1.00	281	0.00	0	0.00	0
subtotal				*3093*			*240*		*0*		*2733*		*120*		*0*

					total fraction	EAEM		EASM		EADM		ORNL Eng	
Title III						fract.	hrs	fract.	hrs	fract.	hrs	fract.	hrs
vendor oversight, inspection	4	hrs/wk	22	89	1.00	0.50	44	0.00	0	0.00	0	0.50	44
Disposition of deviation requests and non-conformances	1	hrs/wk	147	147	1.00	0.20	29	0.00	0	0.00	0	0.80	118
As-built drawings	4	hrs/dwg	71	284	1.00	0.00	0	0.00	0	0.00	0	1.00	284
Installation oversight and inspection	4	hrs/wk	53	210	1.00	0.25	53	0.75	158	0.00	0	0.00	0
subtotal				*730*			*126*		*158*		*0*		*446*

Schedule assumptions	**start**	**duration (weeks)**	**end**

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Engineering, Title I, II and III

Title I Design	Apr-03	31	Nov-03
Title II Design	Nov-03	30	Jun-04
Procurement	Jul-04	22	Dec-04
In-house fab / sub-assy	Jan-05	72	May-06
Installation / final assembly	Sep-05	53	Oct-06

Notes and worksheets

	total	VV holding fixture	3-mod-coil assy fixture	3-mod-coil manipulating fixture	modular coil temporary support fixtures	TF coil sub-assembly frame	TF coil 3-coil assembly manipulator	full field period support fixture	VV port welding fixtures	
Pro-E models	40	4	4	6	4	4	4	4	10	
assy dwgs	20	2	2	4	2	2	2	2	4	
Detail drawings	42	4	4	8	4	4	4	4	10	
installation dwg	9	1	1		1	1		1	4	
cooling schematic	0									
electrical schematic	0									
I&C schematic	0									
stress analysis	8	1	1	1	1	1	1	1	1	
thermal analysis	0									
special analysis	3	1			1			1		seismic analysis
procurement specifications	8	1	1	1	1	1	1	1	1	
preliminary and final design reviews	3	1		1			1			
meetings/reporting/presentations	15%									