

NCSX Fabrication Project Cost and Schedule Estimating Form

WBS 111 Limiters

Labor

Activity Title	Manhours	FY2003 \$\$	Labor Type	Start Date Month/Yr	End Date Month/Yr	Comments
Preliminary Design (Title I)						
(33% of design schedule)	0		<i>EAEM</i>	Feb-06	Apr-06	PPPL Engineer
	0		<i>EADM</i>	Feb-06	Apr-06	PPPL Designer
	171		<i>ORNL Eng</i>	Feb-06	Apr-06	Composite of ORNL Engineer / Designer
	13		<i>ORNL Phys.</i>	Feb-06	Apr-06	Composite of ORNL Physics / scientific
	0		<i>PPPL Phys.</i>	Feb-06	Apr-06	PPPL Physics/scientific
Final Design (Title II)						
(67% of design schedule)	0		<i>EAEM</i>	Apr-06	Jul-06	PPPL Engineer
	0		<i>EADM</i>	Apr-06	Jul-06	PPPL Designer
	343		<i>ORNL Eng</i>	Apr-06	Jul-06	Composite of ORNL Engineer / Designer
	27		<i>ORNL Phys.</i>	Apr-06	Jul-06	Composite of ORNL Physicist
	0		<i>PPPL Phys.</i>	Apr-06	Jul-06	PPPL Physics/scientific
Lab R&D labor						
	0		<i>EAEM</i>	Feb-06	Apr-06	PPPL Engineer
	0		<i>EADM</i>	Feb-06	Apr-06	PPPL Designer
	84		<i>ORNL Eng</i>	Feb-06	Apr-06	Composite of ORNL Engineer / Designer
	32		<i>EASM</i>	Feb-06	Apr-06	PPPL monthly support
	0		<i>EMTB</i>	Feb-06	Apr-06	PPPL Technician
Lab Fab/Assembly/Installation (Title III)						
	29		<i>EAEM</i>	Jul-06	Jan-07	PPPL Engineer
	0		<i>EADM</i>	Jul-06	Jan-07	PPPL Designer
	97		<i>ORNL Eng</i>	Jul-06	Jan-07	Composite of ORNL Engineer / Designer
	32		<i>EASM</i>	Jul-06	Jan-07	PPPL monthly support
	96		<i>EMTB</i>	Jul-06	Jan-07	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	0	0	14	15	0	29
PPPL Designer	<i>EADM</i>	0	0	0	0	0	0	0
Composite of ORNL Engineer / Designer	<i>ORNL Eng</i>	0	0	0	646	49	0	695
PPPL monthly support	<i>EASM</i>	0	0	0	48	16	0	64
PPPL Technician	<i>EMTB</i>	0	0	0	47	49	0	96
Composite of ORNL Physics / scientific	<i>ORNL Phy</i>	0	0	0	40	0	0	40
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	\$1,152	
Procured Hardware/Material	\$3,000	
Profit at 10%	\$415	
<i>total, manf/dev (R&D)</i>	\$4,567	w/o G&A
Procured Hardware/Material		
Graphite tiles	\$20,678	
Hardware	\$8,976	
Thermal shim	\$3,334	
materials for in-house fab	\$0	
subtotal, purchased parts	\$32,988	
Profit at 10%	\$2,068	
<i>total, procured hdwe/matl.</i>	\$68,044	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	\$0	No travel is anticipated for this WBS

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Summary Costs

Activity Title	Manhours	FY2003 \$\$	Comment
Labor			
PPPL Effort	189	\$17,876	<i>Assumed rates:</i> <i>EAEM 153 \$/hr</i> <i>EADM 100 \$/hr</i> <i>ORNL Eng 130 \$/hr</i>
ORNL effort	735	\$96,724	
subtotal, labor	924	\$114,600	
M&S, Other			
Manufacturing Development (R&D)		\$4,567	
Procured Hardware/Material		\$68,044	
Purchased Design Services		\$0	
Procured Installation/Assembly Costs		\$0	
Travel		\$0	
subtotal, M&S		\$72,611	
G&A		\$18,153	25% on all purchased materials, subcontracts, travel
Subtotal without contingency		\$205,363	
Contingency		\$57,502	28% Overall on this WBS
Total cost		\$262,865	

NCSX Fabrication Project Cost and Schedule

WBS 111 Limiters

Engineering, Title I, II and III

Description:

This effort covers all Title I, II, and III engineering for the poloidal limiter system required for Phases I, II, and III of NCSX operation. The parts will be procured from a qualified vendor but any sub-assembly work will be performed in-house at PPPL. All installation oversight will be performed as part of WBS 7.

	multiplier	unit	no.	hours	Labor category											
					total fraction		EAEM		EADM		ORNL Eng		ORNL Physics		PPPL Physics	
					fract.	hrs	fract.	hrs	fract.	hrs	fract.	hrs	fract.	hrs		
Title I, II design																
Pro-E models	2	hrs/model	24	48	1.00	0.00	0	0.00	0	1.00	48	0.00	0	0.00	0	
assy dwgs	40	hrs/dwg	1	40	1.00	0.00	0	0.00	0	1.00	40	0.00	0	0.00	0	
Detail drawings	4	hrs/dwg	24	96	1.00	0.00	0	0.00	0	1.00	96	0.00	0	0.00	0	
installation dwg	40	hrs/dwg	1	40	1.00	0.00	0	0.00	0	1.00	40	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	
stress analysis	40	hrs/calc	1	40	1.00	0.00	0	0.00	0	1.00	40	0.00	0	0.00	0	
thermal analysis	80	hrs/calc	1	80	1.00	0.00	0	0.00	0	1.00	80	0.00	0	0.00	0	
special analysis	40	hrs/calc	1	40	1.00	0.00	0	0.00	0	0.00	0	1.00	40	0.00	0	
procurement specifications	40	hrs/spec	1	40	1.00	0.00	0	0.00	0	1.00	40	0.00	0	0.00	0	
preliminary and final design reviews	40	hrs/rev	2	80	1.00	0.00	0	0.00	0	1.00	80	0.00	0	0.00	0	
meetings/reporting/presentations	10%	% of tot	504	50	1.00	0.00	0	0.00	0	1.00	50	0.00	0	0.00	0	
<i>subtotal</i>				554			0		0		514		40		0	
Title III																
vendor oversight, inspection	4	hrs/wk	12	48	1.00	0.50	24	0.00	0	0.00	0	0.50	24			
in-house fab/assy oversight and inspection	4	hrs/wk	4	16	1.00	0.00	0	1.00	16	0.00	0	0.00	0			
Disposition of deviation requests and non-conformances	1	hrs/wk	26	26	1.00	0.20	5	0.00	0	0.00	0	0.80	21			
As-built drawings	2	hrs/dwg	26	52	1.00	0.00	0	0.00	0	0.00	0	1.00	52			
Installation oversight and inspection	0	hrs/wk	10	0	1.00	0.25	0	0.75	0	0.00	0	0.00	0			
<i>subtotal</i>				142			29		16		0		97			

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Engineering, Title I, II and III

Schedule assumptions	start	duration (weeks)	end
Title I Design, R&D	Feb-06	6	Apr-06
Title II Design	Apr-06	12	Jul-06
Procurement	Jul-06	12	Sep-06
In-house fab / sub-assy	Sep-06	4	Oct-06
Installation / final assembly	Oct-06	10	Jan-07

Notes and worksheets

1. Pro-E models and drawings are repetitive, since each tile is basically the same
2. There are 22 different tile shapes, plus a special nut and thermal isolation gasket

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R&D

Description:
This element covers a simple mechanical test of a typical tile to determine limit loading

Summary
Purchased Design Services \$1,152 w/o G&A
design rate \$120 per hour
Procured Hardware/Material \$3,000 w/o G&A
fab rate \$60 per hour
inspection/technician rate \$80 per hour

R&D design	unit	no.	hours	Labor category											
				total fraction	EAEM fract.	hrs	EADM fract.	hrs	ORNL Eng fract.	hrs	EASM fract.	hrs	Vendor fract.	hrs	
Task															
Pro-E models	12 hrs/model	2	24	1.00	0.00	0	0.00	0	1.00	24	0.00	0	0.00	0	0.00
assy dwgs	40 hrs/dwg	1	40	1.00	0.00	0	0.00	0	1.00	40	0.00	0	0.00	0	0.00
Detail drawings	4 hrs/dwg	1	4	1.00	0.00	0	0.00	0	1.00	4	0.00	0	0.00	0	0.00
installation dwg	0 hrs/dwg	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0	0.00
cooling schematic	0 hrs/dwg	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0	0.00
electrical schematic	0 hrs/dwg	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0	0.00
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	0.00
special analysis	0 hrs/calc	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0	0.00
procurement specifications	8 hrs/spec	1	8	1.00	0.00	0	0.00	0	1.00	8	0.00	0	0.00	0	0.00
vendor shop drawings	0 hrs/dwg	0	0	1.00										1.00	0
vendor part programming	4 hrs/model	2	8	1.00										1.00	8
vendor misc engineering	20% % of tot	8	2	1.00										1.00	2
preliminary and final design reviews	0 hrs/rev	0	0	1.00	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0	0.00
meetings/reporting/presentations	10% % of tot	76	8	1.00	0.00	0	0.00	0	1.00	8	0.00	0	0.00	0	0.00
<i>subtotal</i>			93			0		0		84		0			10

R&D Title III	unit	no.	hours	total fraction	EAEM fract.	hrs	EADM fract.	hrs	ORNL Eng fract.	hrs	EASM fract.	hrs	EMTB fract.	hrs
vendor oversight, inspection	2 hrs/wk	4	8	1.00	0.00	0	0.00	0	0.00	0	1.00	8	0.00	0
in-house fab/assy, oversight, and inspection	4 hrs/wk	4	16	1.00	0.00	0	0.00	0	0.00	0	1.00	16	0.00	0
Testing and experiments	8 hrs/wk	1	8	1.00	0.00	0	0.00	0	0.00	0	1.00	8	0.00	0
<i>subtotal</i>			32			0		0		0		32		0

Schedule assumptions	start	duration (weeks)	end
R&D planning	Feb-06	4	Mar-06
Bid and award	Mar-06	2	Mar-06
R&D procurement / in-house fab.	Mar-06	4	Apr-06
R&D testing	Apr-06	1	Apr-06

Notes and worksheets

Graphite tiles
Number 6 ea
cost per tile (2 x prod. Cost) 156.7 \$/tile
total tile cost \$940

Hardware cost
cost per tile 34.0 \$ for each set of tile hardware
total cost (2 x prod. Cost) \$408

Thermal shim (2xprod.) \$152

Test fixture cost \$1,500 for all

Total parts \$2,999

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Materials and Subcontracts (M&S)

Description:

This effort covers all purchased materials and subcontracts for the poloidal limiter system required for Phases I, II, and III of NCSX operation. The parts will be procured from a qualified vendor but any sub-assembly work will be performed in-house at PPPL. All installation oversight will be performed as part of WBS 7.

Assumptions:

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

Purchased parts:

Graphite tiles \$20,678
 Hardware \$8,976
 Thermal shim \$3,334
subtotal, purchased parts \$32,988

Purchased materials for in-house fabrication and sub-assembly

subtotal purchased materials 0

Worksheet:

Graphite tiles

Number (6*44) 264 ea
 Size:
 width 3.8 in
 height 4 in
 thickness 0.75 in
 volume 11.5 in³
 density 0.08 lbs/in³
 net wt. 0.9 lbs
 gross wt. (100% overage) 1.8 lbs

material unit cost 10 \$/lb
 material cost \$4,838

machining unit time 1 hrs/tile -320.8
 machining unit cost 60 \$/tile
 machining cost \$15,840

total for tiles \$20,678

Hardware cost

tee nuts (2 per tile) 10 \$ ea
 washers (2 per tile) 2 \$ ea
 bolts (2 per tile) 5 \$ ea
 total cost for all tiles \$8,976

Worksheet (continued):

Thermal shim

Number 12 2 half-rings/assy
 Size:
 width 42 in
 height 2 in
 thickness 0.25 in
 volume 21.0 in³
 density 0.3 lbs/in³
 net wt. 6.3 lbs each
 gross wt. (100% overage) 12.6 lbs each

material unit cost 3 \$/lb copper
 material cost \$454

machining unit time 4 hrs
 machining unit cost 240 \$/half ring
 machining cost \$2,880
 total cost for all shims \$3,334

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In-house Fabrication and Assembly

Description:

This effort covers all in-house fab and assembly for the poloidal limiter system required for Phases I, II, and III of NCSX operation. The parts will be procured from a qualified vendor but any sub-assembly work will be performed in-house at PPPL. All installation oversight will be performed as part of WBS 7.

Labor category

	multiplier	unit	no.	hours	total		EAEM		EASM		EMTB		ORNL Eng	
					fraction	hrs	fraction	hrs	fraction	hrs	fraction	hrs		
Fab operations														
(no fab operations needed)				0	0.00	0.00	0	0.00	0	0.00	0	0.00	0	0.00
				0	0.00	0.00	0	0.00	0	0.00	0	0.00	0	0.00
				0	0.00	0.00	0	0.00	0	0.00	0	0.00	0	0.00
				0	0.00	0.00	0	0.00	0	0.00	0	0.00	0	0.00
				0	0.00	0.00	0	0.00	0	0.00	0	0.00	0	0.00
<i>subtotal</i>				0			0		0		0		0	

	multiplier	unit	no.	hours	total		EAEM		EASM		EMTB		ORNL Eng	
					fraction	hrs	fraction	hrs	fraction	hrs	fraction	hrs		
Assembly operations														
receiving inspection	1	man/shift	2	16	1.00	0.00	0	1.00	16	0.00	0	0.00	0	0.00
pre-assemble parts on fixture	1	man/shift	4	32	1.00	0.00	0	0.00	0	1.00	32	0.00	0	0.00
modify as required	1	man/shift	6	48	1.00	0.00	0	0.00	0	1.00	48	0.00	0	0.00
disassemble and store	1	man/shift	2	16	1.00	0.00	0	0.00	0	1.00	16	0.00	0	0.00
					0.00	0.00	0	0.00	0	0.00	0	0.00	0	0.00
<i>subtotal</i>				112			0		16		96		0	

Schedule assumptions	start	duration (weeks)	end
Title I Design, R&D	Sep-05	12	Dec-05
Title II Design	Dec-06	26	Jun-06
Procurement	Jun-06	12	Aug-06
In-house fab / sub-assy	Aug-06	8	Oct-06
Installation / final assembly	Oct-06	10	Jan-07

Notes and worksheets

1. Pro-E models and drawings are repetitive, since each tile is basically the same
2. There are 22 different tile shapes, plus a special nut and thermal isolation gasket