Work Authorization Document

NSTX Upgrade Project

Control Account #:	2480	**Title:**	2nd NBI/TVPS Duct
WBS	1.2.4	**Title:**	NB Injection

Period of Performance: 23 February 2009 through 12 February 2014

Authorized Budget:	$2,260	**Control Account Manager:**	Denault
Revision #:	0	**Revision Date:**	July-11

Authorized Work Description:

This WBS element includes the design, and fabrication of all components connecting the Neutral Beam Box to NSTX, and the connecting ductwork and modifications to NSTX Vacuum Vessel to accommodate the second beamline.

Attachments:

1- A detailed Control Account schedule showing all work packages and planning packages.

2- Budgeted Cost by month.

3- Original Work Authorization Form (WAF)

4- WBS Dictionary sheet that defines the scope of work for this WBS element.

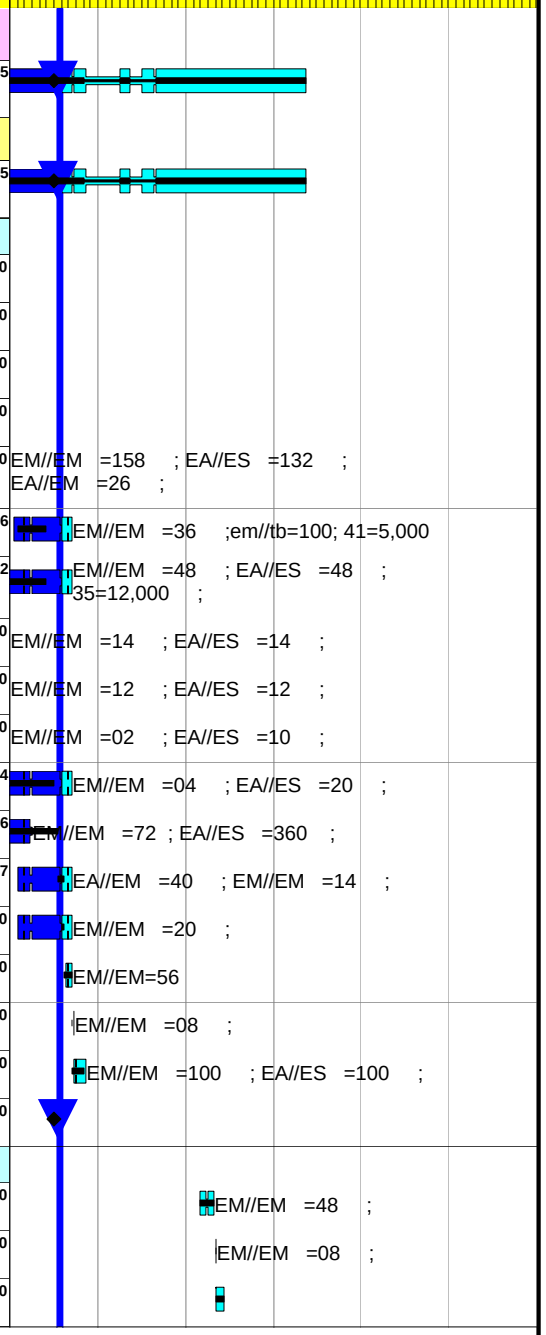
Control Account History

ECP#	Implement Date	Prior Budget	New Budget	Signature

Approvals	Name	Signature	Date
NSTX-U Project Manager	R. Strykowsky		
Control Account Manager	Denault		
Functional Manager	L. Dudek		

NSTX Upgrade Project

Activity ID	Activity Description	Work Days	BASELINE START	Forecast Start	BASELINE FINISH	Forecast Finish	Schedule Slip (Days)	Total Float	Budgeted Cost	PPCT	Earned value cost (BCWP)	Planned value cost (BCWS)
Subtotal		**1,240**	**23FEB09A**	23FEB09A	**12FEB14**	12FEB14	**0**	**1**	2,250,873.17		394,842.42	**416,297.35**
Job: 2480 - 2nd NBI/TVPS Duct & VV-DENAULT												
Subtotal		**1,240**	**23FEB09A**	23FEB09A	**12FEB14**	12FEB14	**0**	**1**	2,250,873.17		394,842.42	**416,297.35**
Design												
2480-0024	**New Coil Comonents F/J-K RWM Coil Re Dsgn**	**22**	**03MAY10A**	03MAY10A	**02JUN10A**	02JUN10A	**0**		0.00	**100**	0.00	**0.00**
2480-0025	**Seismic Analysis**	**5**	**03MAY10A**	03MAY10A	**07MAY10A**	07MAY10A	**0**		0.00	**100**	0.00	**0.00**
2480-0027	**PDR Prep - Duct & VV Mods**	**36**	**03MAY10A**	03MAY10A	**22JUN10A**	22JUN10A	**0**		0.00	**100**	0.00	**0.00**
2480-0028	**CONDUCT PDR - Duct & VV Mods**	**1**	**23JUN10A**	23JUN10A	**23JUN10A**	23JUN10A	**0**		0.00	**100**	0.00	**0.00**
2480-0029	**Disposition PDR Chits - Final Design**	**84***	**03JUN10A**	03JUN10A	**30SEP10A**	30SEP10A	**0**		0.00	**100**	0.00	**0.00**
2480-0029A	**Installation Prototype**	**166***	**01NOV10***	18OCT10A	**28FEB11**	17JUN11	**-78**	**123**	21,304.56	**50**	10,652.28	**21,304.56**
2480-0030	**J-K Cap/Installation Procedure**	**210***	**16AUG10A**	16AUG10A	**28FEB11**	17JUN11	**-78**	**123**	26,670.34	**40**	10,615.96	**26,539.92**
2480-0031	**K- Port Extension**	**41***	**16AUG10A**	16AUG10A	**30SEP10A**	30SEP10A	**0**		0.00	**100**	0.00	**0.00**
2480-0032	**NB- Ceramic-Break**	**47***	**16AUG10A**	16AUG10A	**30SEP10A**	30SEP10A	**0**		0.00	**100**	0.00	**0.00**
2480-0033	**Spool Piece/Round Bellows**	**52***	**16AUG10A**	16AUG10A	**30SEP10A**	30SEP10A	**0**		0.00	**100**	0.00	**0.00**
2480-0034	**Rectangular Bellows Assembly**	**210***	**16AUG10A**	16AUG10A	**31MAR11**	17JUN11	**-55**	**123**	2,344.23	**95**	2,151.21	**2,264.44**
2480-0035	**Design Drawings - Final Design**	**172***	**16AUG10A**	16AUG10A	**15APR11**	31DEC10A	**75**		41,513.09	**100**	41,081.36	**41,081.36**
2480-0037	**Update Analysis - Final Design**	**156***	**18APR11**	01NOV10A	**13MAY11**	17JUN11	**-24**	**123**	9,922.14	**90**	8,929.93	**4,961.07**
2480-0038	**Update Cost & Sched Estimate - Final Dsgn**	**156***	**05MAY11**	01NOV10A	**13MAY11**	17JUN11	**-24**	**123**	3,164.20	**40**	1,265.68	**0.00**
2480-0039	**FDR Prep-Duct & VV Mods**	**21**	**16MAY11**	19MAY11	**13JUN11**	17JUN11	**-4**	**123**	0.00		0.00	**0.00**
2480-0040	**CONDUCT FDR-Duct & VV Mods**	**3**	**14JUN11**	22JUN11*	**14JUN11***	24JUN11	**-8**	**121**	1,265.68		0.00	**0.00**
2480-0041	**Disposition FDR Chits**	**33**	**15JUN11***	27JUN11*	**01AUG11**	11AUG11	**-8**	**328**	24,523.00		0.00	**0.00**
2480PEER	**Peer review**	**0**			**31MAR11**	14APR11A	**-10**		0.00		0.00	**0.00**
Procure, Fab & Assembly												
2480-0042	**Prep Req & Procuremnt Pckg**	**30**	**03DEC12***	03DEC12*	**22JAN13**	22JAN13	**0**	**1**	8,502.72		0.00	**0.00**
2480-0044	**Submit Req to Procurement - 40" VAT Valves (2)**	**1**	**01FEB13***	01FEB13*	**01FEB13**	01FEB13	**0**	**36**	1,417.12		0.00	**0.00**
2480-0045	**Procurement Lead Times - 40" VAT Valves (2)**	**25**	**04FEB13**	04FEB13	**08MAR13**	08MAR13	**0**	**36**	0.00		0.00	**0.00**



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Run Date 20MAY11 10:56

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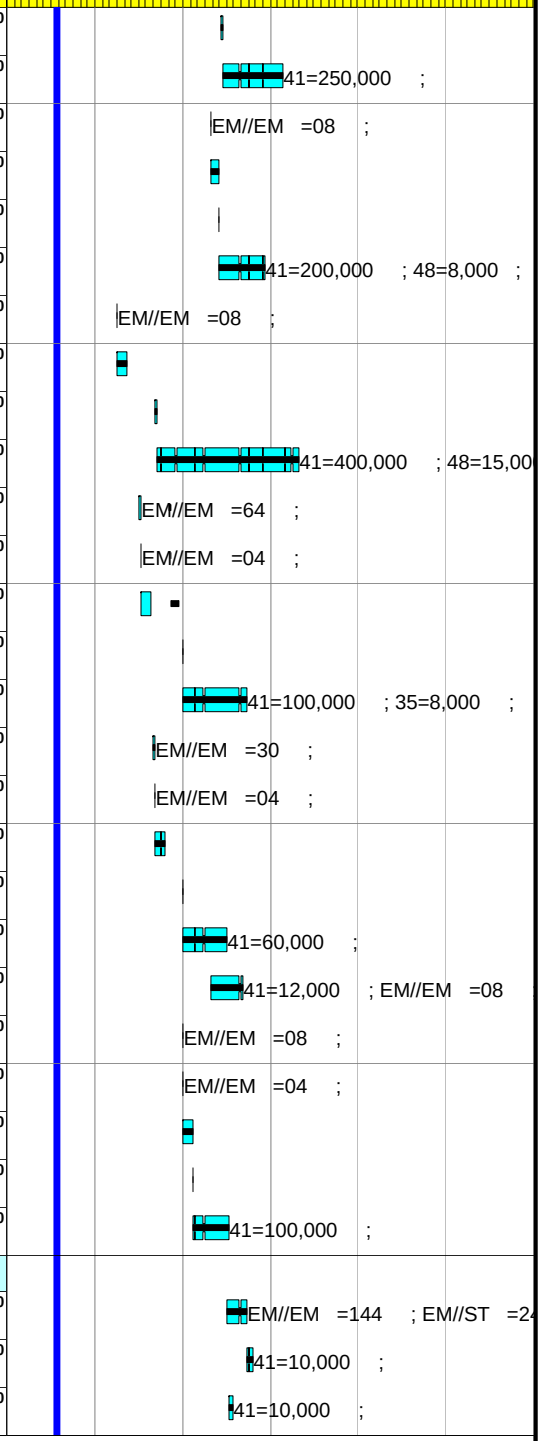
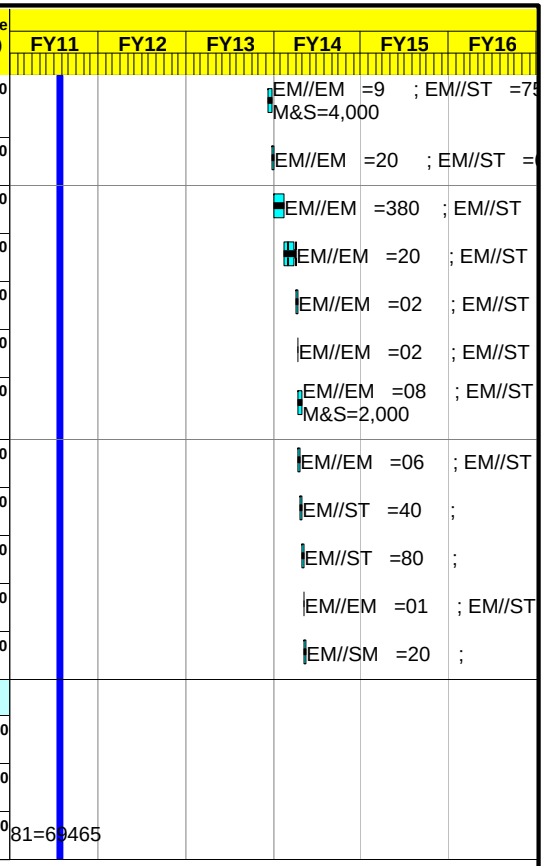
NSTX UPGRADES
RESOURCE LOADED SCHEDULE
CD-2 Schedule
April 2011

Early Bar
Progress Bar
Critical Activity

Activity ID	Activity Description	Work Days	BASELINE START	Forecast Start	BASELINE FINISH	Forecast Finish	Schedule Slip (Days)	Total Float	Budgeted Cost	PPCT	Earned value cost (BCWP)	Planned value cost (BCWS)
2480-0046	Award - - 40" VAT Valves (2)	3	11MAR13	11MAR13	13MAR13	13MAR13	0	36	0.00		0.00	0.00
2480-0047	Fabricate / Delivery - 40" VAT Valves (2)	180	14MAR13	14MAR13	26NOV13	26NOV13	0	36	331,708.33		0.00	0.00
2480-0049	Submit Req to Procurement - 40" Bellows Section	1	23JAN13*	23JAN13*	23JAN13	23JAN13	0	1	1,417.12		0.00	0.00
2480-0050	Procurement Lead Time - 40" Bellows Section	25	24JAN13	24JAN13	27FEB13	27FEB13	0	1	0.00		0.00	0.00
2480-0051	Award - 40" Bellows Section	3	28FEB13	28FEB13	04MAR13	04MAR13	0	1	0.00		0.00	0.00
2480-0052	Fabricate / Delivery - 40" Bellows Section	130	05MAR13	05MAR13	06SEP13	06SEP13	0	1	272,640.00		0.00	0.00
2480-0054	Submit Req to Proc-Rectangular Bellows Section	1	03JAN12*	03JAN12*	03JAN12	03JAN12	0	89	1,387.92		0.00	0.00
2480-0055	Procurement Lead Time-Rectangular Bellows Sectn	25	04JAN12	04JAN12	07FEB12	07FEB12	0	89	0.00		0.00	0.00
2480-0056	Award-Rectangular Bellows Section	1	11JUN12*	11JUN12*	11JUN12	11JUN12	0	2	0.00		0.00	0.00
2480-0057	Fabricate / Delivery-Rectangular Bellows Section	400	12JUN12	12JUN12	27JAN14	27JAN14	0	2	507,828.38		0.00	0.00
2480-0059	Prep Req & Procuremnt Pckg - Vessel Cap & Port E	8	01AUG12*	02APR12*	10AUG12	11APR12	85	195	11,103.36		0.00	0.00
2480-0060	Submit Req to Procurement - Vessel Cap & Port Ex	1	13AUG12	12APR12	13AUG12	12APR12	85	195	693.96		0.00	0.00
2480-0061	Procurement Lead Times - Vessel Cap & Port Exten	25	14AUG12	13APR12	18SEP12	17MAY12	85	195	0.00		0.00	0.00
2480-0062	Award - Vessel Cap & Port Extension	1	01OCT12*	01OCT12*	01OCT12	01OCT12	0	102	0.00		0.00	0.00
2480-0063	Fabricate / Delivery - Vessel Cap & Port Extensn	180	02OCT12*	02OCT12*	24JUN13	24JUN13	0	102	142,640.00		0.00	0.00
2480-0064	Prep Req & Procuremnt Pckg - Spool Piece	5	01JUN12*	01JUN12*	07JUN12	07JUN12	0	257	5,204.70		0.00	0.00
2480-0065	Submit Req to Procurement - Spool Piece	1	08JUN12	08JUN12	08JUN12	08JUN12	0	257	693.96		0.00	0.00
2480-0066	Procurement Lead Times - Spool Piece	25	11JUN12	11JUN12	16JUL12	16JUL12	0	257	0.00		0.00	0.00
2480-0067	Award - Spool Piece	1	03OCT12*	03OCT12*	03OCT12	03OCT12	0	202	0.00		0.00	0.00
2480-0068	Fabricate / Delivery - Spool Piece	120	04OCT12*	04OCT12*	02APR13	02APR13	0	202	79,200.00		0.00	0.00
2480-0070	Fabricate / Delivery - RWM Coil Mtrl (cooper)	100	23JAN13*	23JAN13*	12JUN13	12JUN13	0	142	17,257.12		0.00	0.00
2480-0072	Prep Req & Procuremnt Pckg-Raw Material f/Duct	3	01OCT12*	01OCT12*	03OCT12	03OCT12	0	183	3,188.52		0.00	0.00
2480-0073	Submit Req to Procurement -Other Material f/Duct	1	04OCT12	04OCT12	04OCT12	04OCT12	0	183	708.56		0.00	0.00
2480-0074	Procurement Lead Time - Other Material for Duct	25	05OCT12	05OCT12	08NOV12	08NOV12	0	183	0.00		0.00	0.00
2480-0075	Award - Other Material for Duct	1	09NOV12	09NOV12	09NOV12	09NOV12	0	183	0.00		0.00	0.00
2480-0076	Fabricate / Delivery-Other Mtrl f/Duct	100	12NOV12*	12NOV12*	11APR13	11APR13	0	183	132,000.00		0.00	0.00
Installation												
2480-0077	Installation Procedure - Duct & VV Mods	60	01APR13*	01APR13*	24JUN13	24JUN13	0	32	28,174.08		0.00	0.00
2480-0078	Installation Material - Duct & VV Mods	20	25JUN13*	25JUN13*	24JUL13	24JUL13	0	32	26,400.00		0.00	0.00
2480-0078A	Duct Cladding Installation	10	12APR13	12APR13	25APR13	25APR13	0	191	8,081.92		0.00	0.00



Activity ID	Activity Description	Work Days	BASELINE START	Forecast Start	BASELINE FINISH	Forecast Finish	Schedule Slip (Days)	Total Float	Budgeted Cost	PPCT	Earned value cost (BCWP)	Planned value cost (BCWS)
2480-0081	Install Vessel Supports/Prep Machine	12	09SEP13	09SEP13	24SEP13	24SEP13	0	1	15,205.26		0.00	0.00
2480-0082	Remove Bay-K Nozzle	8	25SEP13	25SEP13	04OCT13	04OCT13	0	1	10,945.20		0.00	0.00
2480-0083	Cut J-K opening	30	07OCT13	07OCT13	15NOV13	15NOV13	0	1	97,336.00		0.00	0.00
2480-0084	Fit Up/Install Cap	25	18NOV13	18NOV13	03JAN14	03JAN14	0	1	49,598.80		0.00	0.00
2480-0085	Install Duct Supports	3	06JAN14	06JAN14	08JAN14	08JAN14	0	1	3,696.64		0.00	0.00
2480-0086	Install K Extension	2	09JAN14	09JAN14	10JAN14	10JAN14	0	1	2,203.72		0.00	0.00
2480-0086A	RWM Coil Installation	10	13JAN14	13JAN14	24JAN14	24JAN14	0	3	12,203.92		0.00	0.00
2480-0088	Make up NB2 Transition Duct	7	13JAN14*	13JAN14*	21JAN14	21JAN14	0	1	10,056.36		0.00	0.00
2480-0089	Leak Check Duct	5	22JAN14	22JAN14	28JAN14	28JAN14	0	1	4,593.60		0.00	0.00
2480-0090	Install Transition Duct	5	29JAN14	29JAN14	04FEB14	04FEB14	0	1	9,187.20		0.00	0.00
2480-0091	Install, Connect Bake Out Lines	1	05FEB14	05FEB14	05FEB14	05FEB14	0	1	1,101.86		0.00	0.00
2480-0092	PTP Testing - Duct & VV Mods	5	06FEB14	06FEB14	12FEB14	12FEB14	0	1	3,643.60		0.00	0.00
FY092480	FY09 Actual Cost	22*	23FEB09A	23FEB09A	30SEP09A	30SEP09A	0		183,352.00	100	183,352.00	183,352.00
FY102480	FY10 Actual Cost	143	01OCT09A	01OCT09A	30APR10A	30APR10A	0		101,704.00	100	101,704.00	101,704.00
FY102480A	FY10 Actual Cost	110	03MAY10A	03MAY10A	30SEP10A	30SEP10A	0		35,090.00	100	35,090.00	35,090.00



2480 2nd NBI/TVPS Duct (Denault)	START	28FEB2009	31MAR2009	30APR2009	31MAY2009	30JUN2009	31JUL2009	31AUG2009	30SEP2009	31OCT2009	30NOV2009	31DEC2009
BCWS	0	6	26	26	24	26	26	25	25	16	14	12
CUM BCWS	0	6	32	58	82	108	134	159	183	199	213	225
BCWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM BCWP	0	0	0	0	0	0	0	0	0	0	0	0
ACWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM ACWP	0	0	0	0	0	0	0	0	0	0	0	0
CV	0	0	0	0	0	0	0	0	0	0	0	0
SV	.	-6.	-32.	-58.	-82.	-108.	-134.	-159.	-183.	-199.	-213.	-225.
CPI	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SPI	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

2480 2nd NBI/TVPS Duct (Denault)	31JAN2010	28FEB2010	31MAR2010	30APR2010	31MAY2010	30JUN2010	31JUL2010	31AUG2010	30SEP2010	31OCT2010	30NOV2010	31DEC2010
BCWS	14	14	16	16	7	7	7	13	16	10	15	13
CUM BCWS	239	253	269	285	292	299	306	319	335	345	360	373
BCWP	0	0	0	0	0	0	0	0	0	0	0	385
CUM BCWP	0	0	0	0	0	0	0	0	0	0	0	385
ACWP	0	0	0	0	0	0	0	0	0	0	0	390
CUM ACWP	0	0	0	0	0	0	0	0	0	0	0	390
CV	0	0	0	0	0	0	0	0	0	0	0	-5
SV	-239.	-253.	-269.	-285.	-292.	-299.	-306.	-319.	-335.	-345.	-360.	12.
CPI	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	.99
SPI	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.03

2480 2nd NBI/TVPS Duct (Denault)	31JAN2011	28FEB2011	31MAR2011	30APR2011	31MAY2011	30JUN2011	31JUL2011	31AUG2011	30SEP2011	31OCT2011	30NOV2011	31DEC2011
BCWS	16	15	6	8	13	14	15	1	0	0	0	0
CUM BCWS	388	403	410	417	430	444	459	460	460	460	460	460
BCWP	0	5	0	5	0	0	0	0	0	0	0	0
CUM BCWP	385	390	390	396	396	396	396	396	396	396	396	396
ACWP	6	1	13	4	0	0	0	0	0	0	0	0
CUM ACWP	396	397	410	414	414	414	414	414	414	414	414	414
CV	-11	-7	-19	-18	-18	-18	-18	-18	-18	-18	-18	-18
SV	-3.	-13.	-19.	-22.	-35.	-49.	-64.	-64.	-64.	-64.	-64.	-64.
CPI	.97	.98	.95	.96	.96	.96	.96	.96	.96	.96	.96	.96
SPI	0.99	0.97	0.95	0.95	0.92	0.89	0.86	0.86	0.86	0.86	0.86	0.86

2480 2nd NBI/TVPS Duct (Denault)	31JAN2012	29FEB2012	31MAR2012	30APR2012	31MAY2012	30JUN2012	31JUL2012	31AUG2012	30SEP2012	31OCT2012	30NOV2012	31DEC2012
BCWS	1	0	0	0	0	22	26	39	23	60	74	84
CUM BCWS	462	462	462	462	462	484	509	548	571	632	706	790
BCWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM BCWP	396	396	396	396	396	396	396	396	396	396	396	396
ACWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM ACWP	414	414	414	414	414	414	414	414	414	414	414	414
CV	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18
SV	-66.	-66.	-66.	-66.	-66.	-88.	-114.	-152.	-176.	-236.	-310.	-394.
CPI	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96
SPI	0.86	0.86	0.86	0.86	0.86	0.82	0.78	0.72	0.69	0.63	0.56	0.5

2480 2nd NBI/TVPS Duct (Denault)	31JAN2013	28FEB2013	31MAR2013	30APR2013	31MAY2013	30JUN2013	31JUL2013	31AUG2013	30SEP2013	31OCT2013	30NOV2013	31DEC2013
BCWS	93	80	143	161	147	126	137	111	94	137	109	58
CUM BCWS	883	963	1,106	1,268	1,415	1,541	1,678	1,789	1,882	2,020	2,128	2,186
BCWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM BCWP	396	396	396	396	396	396	396	396	396	396	396	396
ACWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM ACWP	414	414	414	414	414	414	414	414	414	414	414	414
CV	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18
SV	-487.	-568.	-711.	-872.	-1019.	-1145.	-1282.	-1393.	-1486.	-1624.	-1732.	-1791.
CPI	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96
SPI	0.45	0.41	0.36	0.31	0.28	0.26	0.24	0.22	0.21	0.2	0.19	0.18

2480 2nd NBI/TVPS Duct (Denault)	31JAN2014	28FEB2014	31MAR2014	30APR2014	31MAY2014	30JUN2014	31JUL2014	31AUG2014	30SEP2014	31OCT2014	30NOV2014	31DEC2014
BCWS	66	8	0	0	0	0	0	0	0	0	0	0
CUM BCWS	2,252	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260	2,260
BCWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM BCWP	396	396	396	396	396	396	396	396	396	396	396	396
ACWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM ACWP	414	414	414	414	414	414	414	414	414	414	414	414
CV	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18
SV	-1856.	-1865.	-1865.	-1865.	-1865.	-1865.	-1865.	-1865.	-1865.	-1865.	-1865.	-1865.
CPI	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96
SPI	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18

Annex I – WBS Dictionary

This Work Breakdown Structure (WBS) organizes and defines the scope of the NSTX Upgrade using the WBS as established by the original NSTX project and modified to accommodate the NSTX Upgrade.

WBS L1	L2	L3	Description
1			**NSTX UPGRADE PROJECT**
	1.1		**Torus Systems**
		1.1.0	Project Integrated Model
		1.1.1	Plasma Facing Components
		1.1.2	Vacuum Vessel and Support Structure
		1.1.3	Magnet Systems
	1.2		**Plasma Heating and Current Drive Systems**
		1.2.1	High Harmonic Fast Wave (HHFW)
		1.2.2	Coaxial Helicity Injection (CHI) Current Drive
		1.2.3	Electron Cyclotron Heating (ECH)
		1.2.4	Neutral Beam Injection (NBI)
	1.3		**Auxiliary Systems**
		1.3.1	Vacuum Pumping System
		1.3.2	Coolant Systems
		1.3.3	Bakeout Heating System
		1.3.4	Gas Delivery System
		1.3.5	Glow Discharge Cleaning System
	1.4		**Plasma Diagnostics**
		1.4.1	Plasma Diagnostics
	1.5		**Power Systems**
		1.5.1	AC Power Systems
		1.5.2	AC/DC Converters
		1.5.3	DC Systems
		1.5.4	Control and Protection System
		1.5.5	General Power Systems and Integration
	1.6		**Central Instrumentation and Controls (I&C)**
		1.6.1	Control System
		1.6.2	Data Acquisition System
	1.7		**Project Support & Integration**
		1.7.1	Project Management and Integration
		1.7.2	Project Physics
		1.7.3	Integrated Systems Tests
	1.8		**Site Preparation and Assembly**
		1.8.1	Site Preparation
		1.8.2	Torus Assembly and Construction

{NBI Controls & Instrumentation (Job 2475)}

WBS Element: 1.2.4.8 **WBS Level: 4**
WBS Title: NSTX Beamline 2 Duct & vacuum Vessel Modifications
Definition: This WBS element includes the design, and fabrication of all components connecting the Neutral Beam Box to NSTX, and the connecting ductwork and modifications to NSTX Vacuum Vessel to accommodate the second beamline.
{NSTX NB2 Duct & VV Mods (Job 2480)}

WBS Element: 1.2.4.9 **WBS Level: 4**
WBS Title: NSTX Test Cell Equipment Removals/Relocations
Definition: This WBS element covers moving of racks and diagnostics to clear space in the NSTX Test Cell (NTC) for the second Neutral Beamline. Racks to be removed and re-installed in a new location are #419, 431-435, 440-445, 447-449, 488. Racks 456 and 489 will be removed and excess. This scope also includes the fabrication and installation of five sections of platform at elevation 118' on the west side of the NTC to accommodate the racks being re-installed in the NTC. Racks #441-445 will be relocated to the Gallery east of the NTC. Diagnostics to be removed are those from the midplanes of Bay J and Bay K as well as those on the present pump duct. The diagnostics from Bay J will be re-installed ~5" outboard of their present position. IR windows and the Transmission Grating Spectrometer will be relocated to the new NB duct. Ion gages, filaments and the RGA will be relocated to the new pump duct under the NB2 duct. SPRED and LOWEUS will be relocated to Bay L. The Thomson Scattering Beam Dump Window will be relocated to between Bays K and L.
{NTC Equipment Removals/Relocations (Job 2490)}

WBS Element: 1.3 **WBS Level: 2**
WBS Title: Auxiliary Systems
Definition: The auxiliary systems include all the mechanical non-torus support systems for NSTX. This WBS element includes the Vacuum Pumping System, the Coolant Systems, the Bakeout Heating System, Gas Delivery System and the Glow Discharge Cleaning System. The scope of the work contains engineering design, R&D, mockups, procurement activities, component fabrication, and System Testing. Installation of the WBS 3 systems is included in the individual WBS 3, level 3 elements.

WBS Element: 1.3.1 **WBS Level: 3**
WBS Title: Vacuum Pumping System
Definition: The Vacuum Pumping System provides the source and distribution of all vacuum pumping to NSTX. This includes the roughing pumps as well as the turbo pumps and any backing pumps to:

- Provide the initial high vacuum environment with minimum impurities for plasma formation;

Work Approval Form (WAF)

Cost Center: 9418
Job Number: 2480
Job Title: NSTX NB2 Duct & VV Mods
Job Manager: Craig Priniski
Rev 1 6/10/2010

Description:

This job includes the design, and fabrication of all components connecting NB Box to NSTX, the connecting ductwork and modifications to NSTX Vacuum Vessel are inculded in this job.

Schedule:

Refer to Primavera Data-Base

Approvals:

Craig Priniski 7-20-10
Job Manager

8/3/10
Project Manager

8/3/10
Engineering Department Head

Cost Center: 9418
Job Number: 2480
Job Title: NSTX NB2 Duct & VV Mods
Job Manager: Craig Priniski

			SCHEDULE								Estimate (user input)														
	USER INPUT TASKS AND DESCRIPTIONS		USER INPUT								FY10$K					HOURS									
task numb	P3 cross ref	TASK DESCRIPTION	Responsible	Duration in WORK DAYS	OPTIONAL Logical Pre-requisites (one task numbers in each column ,any order)				User Input Start Date (optional)	actual= A	M&S (41)	CREDIT CARD (43)	OTHER (39)	TRAVEL (35)	OVERTIME (31)	EA** EM (analysis engr)	EA** DM (Designer)	EE** EM (Elctr Engr)	EE** SM/TB (Electr Tech)	EM** EM (FO&M Engr)	EM** SM/TB (FO&M Tech)	FC** AM (P&C Officer)	Basis of Estimate and Names of req'd skills if known	Category	% Uncertanty positive	negative
		Conceptual Design																								
1		CD for NSTX VV in Bay J-K area	PRINISKI	10					8/10/2009								20			20			COMPLETED	8	NA	
2		CD of Port K Extension	PRINISKI	3					8/24/2009								12			8			COMPLETED	8	NA	
3		CD Ceramic Break Flanges	PRINISKI	10					8/10/2009								20			20			COMPLETED	8	NA	
4		CD Spool Piece	PRINISKI	3					8/10/2009								16			8			COMPLETED	8	NA	
5		C&S Development	PRINISKI	10					7/13/2009											8			COMPLETED	8	NA	
6		C&S Review	PRINISKI	1					7/27/2009											2			COMPLETED	8	NA	
7		NSTX J-K Mockup purchase	PRINISKI	25					8/24/2009		$4									2			COMPLETED	8	NA	
8		Prep for PPPL/Ext CDR	PRINISKI	5					8/27/2009														COMPLETED	8	NA	
9		PPPL CDR	PRINISKI	1					9/28/2009														COMPLETED	8	NA	
		Preliminary Design																								
10		CDR Chit Resolution (all areas)	PRINISKI	30					9/29/2009								41			120			COMPLETED	8	NA	
11		FMEA Analysis	PRINISKI	2					2/15/2010											16			COMPLETED	8	NA	
12		NSTX VV Modification Prototyping	PRINISKI	60					2/18/2010		$6						19			120	5		COMPLETED	8	NA	
13		Update Cost & Schedule Estimate	PRINISKI	18					3/23/2010											72			COMPLETED	8	NA	
14		**Design Components**	PRINISKI						11/10/2009											169				8		
15		J-K Cap Weldment	PRINISKI	45					11/10/2009								144			54			COMPLETED	8	NA	
16		K-Port Extension	PRINISKI	10					2/17/2010								28			12			COMPLETED	8	NA	
17		NB-Ceramic Beak	PRINISKI	7					1/15/2010								17			3			COMPLETED	8	NA	
18		Spool Piece	PRINISKI	10					1/26/2010								28			4			COMPLETED	8	NA	
19		Round Bellows	PRINISKI	10					2/9/2010								24			4			COMPLETED	8	NA	
20		Rectangular Bellows	PRINISKI	10					3/1/2010								32			16			COMPLETED	8	NA	
21		Bay K/NB Duct Supports	PRINISKI	59					2/9/2010								71			5			COMPLETED	8	NA	
22		**J-K RWM Coil Redesign**	PRINISKI	32					4/12/2010															8		
23		New Layout/Supports	PRINISKI	10					4/12/2010								20			12			COMPLETED	8	NA	
24		New Coil Components	PRINISKI	22					4/26/2010								18			18			COMPLETED	8	NA	
25		NB Duct Thermal Shielding	PRINISKI	25					4/19/2010								10			50			COMPLETED	8	NA	
26		PDR Prep	PRINISKI	43					4/15/2010							-	0			0			Work to date	8	NA	
27		CONDUCT PDR	PRINISKI	1					6/23/2010														Prev. Reviews	8	0	
28		Disposition PDR Chits	PRINISKI	33					6/24/2010							26	132			158			Prev. Reviews	8	20	-10
		Final Design																								
29		Seismic Analysis	PRINISKI	5					7/6/2010											24			Prev. Experince	8	10	-10
29		J-K Cap/Installation Procedure	PRINISKI	24					8/10/2010								48			48			Work to date	8	25	-5
30		K- Port Extension	PRINISKI	7					9/13/2010								14			14			Work to date	8	15	-10
31		NB- Ceramic-Break	PRINISKI	6					9/22/2010								12			12			Work to date	8	15	-5
32		Spool Piece/Round Bellows	PRINISKI	5					9/30/2010								10			2			Work to date	8	15	-15
33		Rectangular Bellows Assembly	PRINISKI	5					9/30/2010								20			4			Work to date	8	15	0
34		Design Drawings	PRINISKI	45					10/7/2010								360			72			Prev. Experince	4	10	-10
35		Installation Prototyping	PRINISKI	15					9/13/2010		$5									12	40		Work to date	8	20	-10
36		Update Analyses	PRINISKI	35					8/10/2010							40				14			Work to date	8	20	-40
37		Update Cost & Schedule Estimate	PRINISKI	5					10/7/2010											20			Prev. Updates	8	10	-10
38		FDR Prep	PRINISKI	20					1/10/2011							0	0			0			Prev. Reviews	8	10	-10
39		CONDUCT FDR	PRINISKI	1					3/28/2011														Prev. Reviews	8	NA	0
40		Disposition FDR Chits	PRINISKI	20					3/29/2011								100			100			Prev. Reviews	8	20	-20

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			SCHEDULE																					
											Estimate (user input)													
											FY10$K					HOURS								
	USER INPUT TASKS AND DESCRIPTIONS		USER INPUT																					
task	TASK DESCRIPTION	Responsible	Duration in WORK DAYS	OPTIONAL Logical Pre-requisites (one task numbers in each column ,any order)				User Input Start Date (optional)	actual= A	M&S (41)	CREDIT CARD (43)	OTHER (39)	TRAVEL (35)	OVERTIME (31)	EA** EM (analysis engr)	EA** DM (Designer)	EE** EM (Elctr Engr)	EE** SM/TB (Electr Tech)	EM** EM (FO&M Engr)	EM** SM/TB (FO&M Tech)	FC** AM (P&C Officer)	Basis of Estimate and Names of req'd skills if known	Category	% Uncertanty positive	negative
	Procurement	PRINISKI																						
41	Prep Procurement Specs (Early Action Items	PRINISKI	30					2/7/2011											48			Prev. Experince	4	20	-10
42	**Item 1: 40 VAT VALVES x2"**	PRINISKI						3/21/2011		$250												Prev. Quotes	6	15	0
43	SUBMIT REQ TO PROCUREMENT	PRINISKI	1					3/21/2011											8			Prev. Experince	4		
44	Procurement lead time (1)	PRINISKI	25					3/22/2011																	
45	AWARD	PRINISKI	3					4/26/2011																	
46	Fabricate and Delivery	PRINISKI	100					4/29/2011														Prev. Experince	4	15	0
47	**Item 2: 40 Bellows Section"**	PRINISKI						3/21/2011		$200			8									Vendor Quote	6	30	-20
48	SUBMIT REQ TO PROCUREMENT	PRINISKI	1					3/21/2011											8			Prev. Experince	4		
49	Procurement lead time (1)	PRINISKI	25					3/22/2011																	
50	AWARD	PRINISKI	3					4/26/2011																	
51	Fabricate and Delivery	PRINISKI	130					4/29/2011														Vendor Quote	6	20	0
52	**Item 3: Rectangular Bellows Section**	PRINISKI						3/21/2011		$400			15									Prev. Experince	4	35	-20
53	SUBMIT REQ TO PROCUREMENT	PRINISKI	1					3/21/2011											8			Prev. Experince	4		
54	Procurement lead time (1)	PRINISKI	25					3/22/2011																	
55	AWARD	PRINISKI	1					4/26/2011																	
56	Fabricate or delivery	PRINISKI	400					4/27/2011														Vendor Quote	6	50	0
57	**Item 4: Vessel Cap & Port Extension**							4/19/2011		$100			8									Prev. Experince	4	20	-5
58	Prep Requisition and procurement packa	PRINISKI	8					4/19/2011											64			Prev. Experince	4		
59	SUBMIT REQ TO PROCUREMENT	PRINISKI	1					4/29/2011														Prev. Experince	4		
60	Procurement lead time (1)	PRINISKI	25					5/2/2011																	
61	AWARD	PRINISKI	1					6/6/2011																	
62	Fabricate and delivery	PRINISKI	180					6/7/2011														Prev. Experince	4	15	0
63	**Item 5: Spool Piece**	PRINISKI						4/19/2011		$40												Prev. Experince	4	15	-5
64	Prep Requisition and procurement packa	PRINISKI	5					4/29/2011											30			Prev. Experince	4		
65	SUBMIT REQ TO PROCUREMENT	PRINISKI	1					5/6/2011														Prev. Experince	4	NA	
66	Procurement lead time (1)	PRINISKI	25					5/9/2011																	
67	AWARD	PRINISKI	1					6/13/2011																	
68	Fabricate or delivery	PRINISKI	120					6/14/2011														Prev. Experince	4	15	
69	**Item 6: RWM Coil Materials (copper)**	PRINISKI	1					4/19/2011		$12									8			Material Prices	6	15	
70	**Item 7: Raw materials for duct (added shie**	PRINISKI						4/19/2011		$100												Material Prices	6	15	-10
71	Prep Requisition and procurement packa	PRINISKI	3					5/6/2011											18			Prev. Experince	4	10	
72	SUBMIT REQ TO PROCUREMENT	PRINISKI	1					5/11/2011											4			Prev. Experince	4		
73	Procurement lead time (1)	PRINISKI	25					5/12/2011																	
74	AWARD	PRINISKI	1					6/16/2011																	
75	Fabricate or delivery	PRINISKI	100					6/17/2011														Prev. Experince	4	15	-5
	Installation																								
76	Installation Procedure	PRINISKI	60					7/8/2011											144	24		Prev. Experince	4,2	20	-5
	OUTAGE BEGINS							8/29/2012																	
77	Installation materials purchase	PRINISKI	20					8/30/2012		$10												Material Prices	6	30	-20
78	**Installation**	PRINISKI						11/19/2012																	
79	**J-K Vessel Modification**	PRINISKI						2/6/2013																	
80	Install Vessel Supports	PRINISKI	8					2/6/2013											6	51		Exper./Judgent	4,2	15	-5
81	Remove Bay-K Nozzle	PRINISKI	4					2/18/2013											8	64		Exper./Judgent	4,2	15	-5
82	Cut J-K opening	PRINISKI	30					2/28/2013											80	720		Exper./Judgent	4,2	25	-20
83	Fit Up/Install Cap	PRINISKI	25					4/5/2013											20	400		Exper./Judgent	4,2	30	-15
84	Install Duct Supports	PRINISKI	3					9/2/2013											2	29		Exper./Judgent	4,2	15	-5
85	Install K Extension	PRINISKI	2					9/2/2013											2	16		Prev. Experince	4	15	-5
86	**NB2 Duct Construction**	PRINISKI						11/19/2012											10						
87	Make up NB2 Transition Duct	PRINISKI	7					11/19/2012											6	78		Prev. Experince	4	15	-5

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			SCHEDULE				Estimate (user input)															
	USER INPUT TASKS AND DESCRIPTIONS		USER INPUT				FY10$K					HOURS										
task	TASK DESCRIPTION	Responsible	Duration in WORK DAYS	OPTIONAL Logical Pre-requisites (one task numbers in each column ,any order)	User Input Start Date (optional)	actual= A	M&S (41)	CREDIT CARD (43)	OTHER (39)	TRAVEL (35)	OVERTIME (31)	EA** EM (analysis engr)	EA** DM (Designer)	EE** EM (Elctr Engr)	EE** SM/TB (Electr Tech)	EM** EM (FO&M Engr)	EM** SM/TB (FO&M Tech)	FC** AM (P&C Office)	Basis of Estimate and Names of req'd skills if known	Category	% Uncertanty positive	negative
88	Leak Check Duct	PRINISKI	5		11/28/2012												40		Prev. Experince	4	20	-5
89	Install Transition Duct	PRINISKI	5		6/4/2014												80		Prev. Experince	4	20	-5
90	Install, Connect Bake Out Lines	PRINISKI	1		6/11/2014											1	8		Prev. Experince	4	15	-5
91	Testing	PRINISKI	5		6/12/2014												20		Exper./Judgent	2	15	
	END OUTAGE				10/1/2014																	
	TOTALS						$1,127	$0	$0	$31	$0	66	1215	0	0	1697	1575	0				
							$1,328	$0	$0	$38	$0	$12	$144	$0	$0	$253	$235	$0				

TOTAL Preliminary Cost Estimate ($k)= $2,009

Notes:

(1) Procurement lead time:	Weeks
Purchase orders-Commercial, off-the-shelf items	3
Purchase orders-Noncommercial items	5
Subcontracts (non construction)	8
Construction subcontracts	9

CATEGORIZATION CODES:
1 - National Standards
2 - Engineering Judgement/Experience
3 - Estimates/Data from External Sources (e.g., W7X, ATF, etc.)
4 - Previous PPPL/ORNL Experieince (e.g., TFTR, NSTX, PLT, etc.)
5 - Prototype Data/Test Results
6 - Catelogue Price/Vendor Quote
7 - Placed Contracts
8 - Actual experience for NCSX Work
9 - Other

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Uncertainty of the Estimate

		High	Medium	Low	Uncertainty Range (%)	Comments/Other Considerations
	Design Maturity		X		15	
	Design Complexity			X	10	

Residual Impacts

	Risk Description	Likelihood of Occurring	Mitigation Plan	Basis of estimate	Cost Impact Low ($K)	Cost Impact High ($K)	Schedule Impact Low (weeks)	Schedule Impact High (Weeks)
1	Price increase for Rectangular Bellows	U	Conginancy money may be need to be set aside	Dicussions with vendors	0	170	0	0
2								
3								
4								
5								

Notes
(1) Cost impacts should NOT include standing army costs which are separately calculated from the schedule impact
(2) 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.
Likelihood of occurrence should be entered consistent with our risk classification methodology, i.e.
(3) VL= Very Likely (P>80%), L=Likely (80%>P>40%), U=Unlikley (40%>P>10%), VU=Very Unlikely (P<10%), NC=Non-credible (P<1%)

Design Maturity	Design Complexity: Low		Medium		High	
Low	-15%	+25%	-20%	+40%	-30%	+60%
Medium	-10%	+15%	-15%	+25%	-20%	+40%
High	-5%	+10%	-10%	+15%	-15%	+25%

Design Maturity Definition

High

Final design available. All design features/requirements well known. No further design development or evolution expected that will impact estimate.

Medium

Preliminary design available. Some additional design evolution likely. Further developments can be somewhat expected or anticipated and reflected in estimate.

Low

No better than conceptual design basis currently available. Design details, procedures, etc. still need much development and evolution of requirements beyond estimate basis is likely and expected.

Design Complexity Definition

Low

Work is fairly well understood -- either standard construction or repetition of activities performed in past. Little likelihood of estimate not being well understood and requirements not being well defined.

Medium

More complex work requirements that have potential to impact cost and schedule estimates. Limited experience performing similar tasks, so ability to estimate accurately is somewhat suspect

High

Extremely challenging tasks and/or requirements. Unique or firstof-a-kind assembly or work tasks. No good basis for estimating work exists so there is a high degree of estimate uncertainty.

Based on standard industry and DOE estimate classifications (Per AACEI Recommende

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Materials and Subcontracts (M&S)

Description:			Basis of Estimate
Item 1: 40" VAT VALVES x2	$250K	Based on quotes for propes upgrade, scaled to FY 09 dollars	6- Quote
Item 2: 40" Bellows Section	$200K	Based on Vendor Quotes	6- Quote
Item 3: Rectangular Bellows Section	$400K	Based on OEM Quote	6- Quote and Actual Costs
Item 4: Spool Piece	$40K	Scale up of costs of other vacuum vessel extensions ordered	4 - Experience
Item 5: Vessel Cap & Port Extension	$80K	Scale up of costs of other vacuum vessel extensions ordered	4 - Experience
Item 7: Duct Shielding Material	$140K	Based on recent PPPL purchases of Molly Plate Shielding	8- Actual NSTX Work

CATEGORIZATION CODES:

1 - National Standards
2 - Engineering Judgement/Experience
3 - Estimates/Data from External Sources (e.g., W7X, ATF, etc.)
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9 - Other

TOTALS