

Work Authorization Document

NSTX Upgrade Project

Control Account #:	1002	Title:	Passive Plate Analysis & Upgrade
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WBS	1.1.1	Title:	Plasma Facing Components
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Period of Performance: 4 January 2010 through 23 March 2011

Authorized Budget:	\$251	Control Account Manager:	Titus
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Revision #:	0	Revision Date:	July-11
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Authorized Work Description:

In addition the NSTX Upgrade will require analysis of the passive plates for disruption and thermal loads. CDR level calculations were performed that addressed one of five disruptions. The remaining identified disruptions are to be completed during Preliminary Design. During Final design, analysis updates are expected as a result of preliminary design evolution. Modest hardware upgrades are anticipated as part of this task. Additions of accelerometers or other diagnostics to benchmark calculations with actual performance in NSTX are also anticipated. This analysis effort is included in this WBS element.

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. Strykowski		
Control Account Manager	Titus		
Functional Manager	P. Heitzenroeder		

Activity ID	Activity Description	Work Days	BEGINNING START	Forecast Start	BEGINNING FINISH	Forecast Finish	Schedule Slip (Days)	Total Float	Budgeted Cost	PPCT	Earned value cost (BCWP)	Planned value cost (BCWS)	FY11	FY12	FY13	FY14	FY15	FY16
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NSTX Upgrade Project

Subtotal		461	04JAN10A	04JAN10A	23MAR11	28OCT11	-154	242	253,999.49		238,481.82	250,920.34						
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Job: 1002 -Passive Plate Analysis &Upgrade-TITUS

Subtotal		461	04JAN10A	04JAN10A	23MAR11	28OCT11	-154	242	253,999.49		238,481.82	250,920.34						
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1000-0014	Maintain Disruption Scenarios (xfer from 1000)	241*	01JUL10A	01JUL10A	25FEB11	17JUN11	-79	126	18,705.28	85	15,666.23	18,430.86						
1002-0005	Check/Correct Vector Potential Solution	21	03MAY10A	03MAY10A	01JUN10A	01JUN10A	0		0.00	100	0.00	0.00						
1002-0014	Disposition PDR Chits	144*	02JUN10A	02JUN10A	03JAN11	02DEC10A	16		14,288.68	100	14,413.76	14,413.76						
1002-0015	Check/Correct Vector Potential Solution	200*	02JUN10A	02JUN10A	22MAR11	29OCT10A	94		14,055.04	100	14,693.94	14,693.94						
1002-0016	Run Disruption files based on lower background F	200*	02JUN10A	02JUN10A	22MAR11	29OCT10A	94		10,541.28	100	11,020.46	11,020.46						
1002-0017	Add Halo Loads	262*	02JUN10A	02JUN10A	22MAR11	17JUN11	-62	126	7,432.22	85	6,244.92	7,346.97						
1002-0018	Complete Bolting and Bracket Evaluation	262*	02JUN10A	02JUN10A	22MAR11	17JUN11	-62	126	3,716.11	90	3,306.14	3,673.49						
1002-0019	Monitor fiberoptic Disruption Instrumentation	200*	02JUN10A	02JUN10A	22MAR11	02DEC10A	72		7,144.34	100	7,346.97	7,346.97						
1002-0020	Fatigue Assessment / Evaluation	218*	02JUN10A	02JUN10A	22MAR11	15APR11A	-18		7,376.71	100	7,346.97	7,346.97						
1002-0021	Input to the DCPS	200*	02JUN10A	02JUN10A	22MAR11	29OCT10A	94		7,027.52	100	7,346.97	7,346.97						
1002-0025	Determine Passive Plates Hardware Impact	241*	02JUN10A	02JUN10A	22MAR11	18MAY11	-41	126	3,704.13	75	3,674.62	4,899.49						
1002-0025A	Procure 1000 718 bolts	20		03OCT11*		28OCT11	0	242	5,515.80		0.00	0.00						
1002-0029	Bracket re-work, in-house	241*	02JUN10A	02JUN10A	22MAR11	18MAY11	-41	126	3,704.13	10	367.35	3,673.49						
1002-0030	Drawing Update (As Builts)	241*	02JUN10A	02JUN10A	22MAR11	18MAY11	-41	126	7,408.25	50	3,673.49	7,346.97						
1002-0099	PP analysis complete for FDR	119*	23MAR11*	03JAN11A	23MAR11	17JUN11	-61	126	0.00	75	0.00	0.00						
FY101002	FY10 Actual Cost	105	04JAN10A	04JAN10A	28MAY10A	28MAY10A	0		84,302.00	100	84,302.00	84,302.00						
FY101002A	FY10 Actual Cost	110	03MAY10A	03MAY10A	30SEP10A	30SEP10A	0		59,078.00	100	59,078.00	59,078.00						

Data Date: 30APR11
 Run Date: 20MAY11 10:44

1105
 NSTX UPGRADES
 RESOURCE LOADED SCHEDULE
 CD-2 Schedule
 April 2011

Sheet 1 of 1

- Early Bar
- Progress Bar
- Critical Activity

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.

<u>WBS</u>	<u>L1</u>	<u>L2</u>	<u>L3</u>	<u>Description</u>
	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

Annex I – WBS Dictionary

protection, divertor area strike plates, and local I&C. This element consists of the engineering design, analysis, procurement activities and component fabrication.

The NSTX Upgrade Project will require new PFCs on the new Center Stack Casing (CSC) and the new Inboard divertor (IBD). This WBS element includes the design and analysis for both the CS and IBD PFCs, design modifications to the PFC tiles to accommodate surface diagnostics, including design of the tile mounting schemes and routing plans for diagnostic wires, generation of required documentation such as checked calculations, specifications and procedures, the procurement and installation of all PFC tiles and hardware on the CSC and IBD.

{Center Stack Upgrade (CSU) PFCs (Job 1001)}

In addition the NSTX Upgrade will require analysis of the passive plates for disruption and thermal loads. CDR level calculations were performed that addressed one of five disruptions. The remaining identified disruptions are to be completed during Preliminary Design. During Final design, analysis updates are expected as a result of preliminary design evolution. Modest hardware upgrades are anticipated as part of this task. Additions of accelerometers or other diagnostics to benchmark calculations with actual performance in NSTX are also anticipated. This analysis effort is included in this WBS element.

{Passive Plate Analysis and Upgrade Activity (Job 1002)}

With the exception of the modifications identified above, no additional modifications to the PFCs are anticipated.

WBS Element: 1.1.2

WBS Level: 3

WBS Title: Vacuum Vessel and Support Structure

Definition: The vacuum vessel & support structure (VVSS) consists of the vacuum chamber, not including the PFCs, all ports and vacuum boundary closures and the torus support structure which provides the overall supporting mechanism for the torus components to the test cell floor. This WBS element includes the engineering design, analysis, procurement activities and component fabrication.

The NSTX Upgrade Project will require that the existing VVSS be modified to accommodate the new center stack structure, including the umbrella structure and the new center stack support structure. This WBS element includes the analytical and CAD design of the support structures associated with the Magnet upgrade activities. The scope includes; the Vacuum Vessel & Structural Support, the Outer TF Structures, the Outer PF Coil Structures, the Umbrella Structural Reinforcement, the CS Support Pedestal and miscellaneous Vacuum Vessel Structural Supports. It also includes the procurement and fabrication of these structures, but

Work Approval Form (WAF)

Cost Center: 9417
Job Number: 1002
Job Title: Passive Plate Analysis & Upgrade Activities
Job Manager: P. Titus

Description:


This job Continues analysis of the passive Plates for disruption, halo, and thermal loads. PDR level calculations addressed three of five disruptions. The remaining identified disruptions have been completed during Preliminary Design. During Final design, analysis updates are expected as a result of preliminary design evolution. Halo current loads will be applied. Modest hardware upgrades are anticipated. Additions of accelerometers or other diagnostics to benchmark calculations with actual performance in NSTX are also anticipated


Schedule:

See Tab B or attached

Approvals:

 July 21 2010
Job Manager

 8/3/10
Project Manager

 8/3/10
Engineering Department Head



Design Complexity							Design Maturity Definition									
Design Maturity	Low			Medium			High			High	Final design available. All design features/requirements well known. No further design development or evolution expected that will impact estimate.					
	Low	-15%	+25%	-20%	+40%	-30%	+60%	Medium	Preliminary design available. Some additional design evolution likely. Further developments can be somewhat expected or anticipated and reflected in estimate.							
	Medium	-10%	+15%	-15%	+25%	-20%	+40%	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.							
	High	-5%	+10%	-10%	+15%	-15%	+25%	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 first-of-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 Recommended							

Cost Center:
Job Number:
Cost Center:
Job Number:

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9417
1002
Passive Plate Analysis & Upgrade Activities
P. Titus

Materials and Subcontracts (M&S)

Basis of Estimate

Description:

CATEGORIZATION CODES:

1 - National Standards	1	\$	-	#DIV/0!
2 - Engineering Judgement/Experience	2	\$	-	#DIV/0!
3 - Estimates/Data from External Sources (e.g., W7X, ATF, etc.)	3	\$	-	#DIV/0!
4 - Previous PPPL/ORNL Experience (e.g., TFTR, NSTX, PLT, etc.)	4	\$	-	#DIV/0!
5 - Prototype Data/Test Results	5	\$	-	#DIV/0!
6 - Catalogue Price/Vendor Quote	6	\$	-	#DIV/0!
7 - Placed Contracts	7	\$	-	#DIV/0!
8 - Actual experience for NCSX Work	8	\$	-	#DIV/0!
9 - Other	9	\$	-	#DIV/0!

TOTALS

\$ - #DIV/0!

Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total	Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total			

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 2029-2030

OH solenoid	1997 \$ \$136.3	Inflator % 1.2992	2009 \$ \$177.1	x4 k\$ \$708.3	# Orig 2340	# Upgrade 6400	3.0
Conductor	\$7.50		\$105,600.0	\$105.6			
OH conductor	\$40.0	1.2992	\$52.0	\$155.90	6400	2.2	5
	FY97 cost	Escal			12800	\$92.2	

TF bundle \$83.0 1.2992 \$107.8 \$431.3
 \$1,139.66
 \$1,481.56 30% difficulty

OTF Conductor 2 x 3 23 #/ft 3450# 25 ft/length 6

Rotable flanges \$13.2 1.2992 \$17.1
 Inconel Forgings \$30.9 1.2992 \$40.1 1.5 \$60.2

6,400.0

PF Conductors	width in	Height in	Hole Dia in	Hole Area in2	Area in2	Coil R in	Turn	length/Tur in	length/Coil in	length/Coil ft	x 2	Wt/coil lb	x 2		
PF1a	0.591	0.591	0.217	0.1180	0.231	12.571	120	78.946	9473.5	789.5	1578.9	701.1	1402.3		
PF1b	0.220	0.220	0.098	0.0024	0.046	15.763	180	98.992	17818.5	1484.9	2969.7	262.3	524.6		
PF1c	0.220	0.220	0.098	0.0024	0.046	21.674	162	136.113	22050.3	1837.5	3675.0	324.6	649.2		
													2576.0	x 2.2	\$7.50 \$42.5 k

Pi 3.14
 0.32 #/Cu in