Work Authorization Document

NSTX Upgrade Project

Control Account #:	7900	**Title:**	Integrated System
WBS	1.7.3	**Title:**	Project Support and Integration
Period of Performance:	02 November 2009 through 29 September 2014		
Authorized Budget:	$78	**Control Account Manager:**	Gentile
Revision #:	0	**Revision Date:**	July-11

Authorized Work Description:

This element includes all of the activities associated with the support of development of all necessary procedures and documents to support the integrated tests, and to support performance of the pre-operational integrated system tests culminating in first plasma.

The WBS element includes Convening the NSTX Activity Certification Committee (ACC) for comprehensive review the upgrades. Prepare and make presentation to the PPPL ES&H Executive Safety Board for issuance of appropriate Safety Certificate parameters for operation of NSTX with new enhanced operating capabilities; preparation of documentation (procedures) for safely integrating the upgrades for operations within NSTX safe operating parameters; working with NSTX Operations Group for the successful integration of the upgrades.

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.

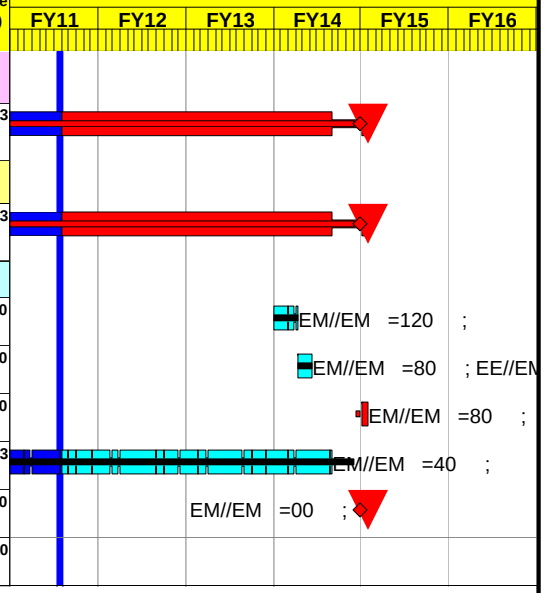
Control Account History

ECP#	Implement Date	Prior Budget	New Budget	Signature

Approvals	Name	Signature	Date
NSTX-U Project Manager	R. Strykowsky		
Control Account Manager	Gentile		
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		1,241	02NOV09A	02NOV09A	29SEP14	27OCT14	-20	-19	78,126.71		5,040.98	4,968.53
Job: 7900 - Integrated System Test-GENTILE												
Subtotal		1,241	02NOV09A	02NOV09A	29SEP14	27OCT14	-20	-19	78,126.71		5,040.98	4,968.53
Integrated System Testing (WBS 1.7 / Job 7900)												
7900-110	Prepare NBI2 & CS ISTP Test Procedures	65	02OCT13*	02OCT13*	14JAN14	14JAN14	0	127	21,976.80		0.00	0.00
7900-120	Conduct ACC Review of Upgrades	40	15JAN14	15JAN14	11MAR14	11MAR14	0	127	30,661.60		0.00	0.00
7900-140	Perform ISTP	15	09SEP14	07OCT14	29SEP14	27OCT14	-20	-19	14,651.20		0.00	0.00
7900-150	Participate in cost and schedule reviews	911*	01OCT10*	01OCT10A	03SEP14	02JUN14	65	84	6,881.11	LOE	1,084.98	1,012.53
7900-999	NSTX RESUME OPERATIONS	0			29SEP14	27OCT14	-20	-19	0.00		0.00	0.00
FY107900	FY10 Actual Cost	40	02NOV09A	02NOV09A	23DEC09A	23DEC09A	0		3,956.00	100	3,956.00	3,956.00



Data Date	**30APR11**	**1105**	**NSTX UPGRADES** **RESOURCE LOADED SCHEDULE** **CD-2 Schedule** **April 2011**	**Sheet 1 of 1**
Run Date	**20MAY11 11:06**			

Early Bar
Progress Bar
Critical Activity

7900 Integrated System (Gentile)	START	28FEB2009	31MAR2009	30APR2009	31MAY2009	30JUN2009	31JUL2009	31AUG2009	30SEP2009	31OCT2009	30NOV2009	31DEC2009
BCWS	0	0	0	0	0	0	0	0	0	0	2	2
CUM BCWS	0	0	0	0	0	0	0	0	0	0	2	4
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	.	.	.	.	.	.	.	.	.	.	-2.	-4.
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

7900 Integrated System (Gentile)		31JAN2010	28FEB2010	31MAR2010	30APR2010	31MAY2010	30JUN2010	31JUL2010	31AUG2010	30SEP2010	31OCT2010	30NOV2010	31DEC2010
	BCWS	0	0	0	0	0	0	0	0	0	0	0	0
	CUM BCWS	4	4	4	4	4	4	4	4	4	4	4	4
	BCWP	0	0	0	0	0	0	0	0	0	0	0	4
	CUM BCWP	0	0	0	0	0	0	0	0	0	0	0	4
	ACWP	0	0	0	0	0	0	0	0	0	0	0	4
	CUM ACWP	0	0	0	0	0	0	0	0	0	0	0	4
	CV	0	0	0	0	0	0	0	0	0	0	0	0
	SV	-4.	-4.	-4.	-4.	-4.	-4.	-4.	-4.	-4.	-4.	-4.	.
	CPI	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.09
	SPI	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1

7900 Integrated System (Gentile)		31JAN2011	28FEB2011	31MAR2011	30APR2011	31MAY2011	30JUN2011	31JUL2011	31AUG2011	30SEP2011	31OCT2011	30NOV2011	31DEC2011
	BCWS	0	0	0	0	0	0	0	0	0	0	0	0
	CUM BCWS	4	5	5	5	5	5	5	5	6	6	6	6
	BCWP	0	0	0	0	0	0	0	0	0	0	0	0
	CUM BCWP	4	5	5	5	5	5	5	5	5	5	5	5
	ACWP	0	0	0	0	0	0	0	0	0	0	0	0
	CUM ACWP	4	4	4	4	4	4	4	4	4	4	4	4
	CV	0	1	1	1	1	1	1	1	1	1	1	1
	SV	.	.	.	.	.	.	.	-1.	-1.	-1.	-1.	-1.
	CPI	1.12	1.16	1.19	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23
	SPI	1	1	1	1	0.97	0.95	0.92	0.9	0.88	0.85	0.83	0.81

7900 Integrated System (Gentile)		31JAN2012	29FEB2012	31MAR2012	30APR2012	31MAY2012	30JUN2012	31JUL2012	31AUG2012	30SEP2012	31OCT2012	30NOV2012	31DEC2012
	BCWS	0	0	0	0	0	0	0	0	0	0	0	0
	CUM BCWS	6	6	6	7	7	7	7	7	7	7	8	8
	BCWP	0	0	0	0	0	0	0	0	0	0	0	0
	CUM BCWP	5	5	5	5	5	5	5	5	5	5	5	5
	ACWP	0	0	0	0	0	0	0	0	0	0	0	0
	CUM ACWP	4	4	4	4	4	4	4	4	4	4	4	4
	CV	1	1	1	1	1	1	1	1	1	1	1	1
	SV	-1.	-1.	-2.	-2.	-2.	-2.	-2.	-2.	-2.	-3.	-3.	-3.
	CPI	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23
	SPI	0.79	0.77	0.76	0.74	0.72	0.71	0.69	0.68	0.66	0.65	0.64	0.62

7900 Integrated System (Gentile)	31JAN2013	28FEB2013	31MAR2013	30APR2013	31MAY2013	30JUN2013	31JUL2013	31AUG2013	30SEP2013	31OCT2013	30NOV2013	31DEC2013
BCWS	0	0	0	0	0	0	0	0	0	7	6	7
CUM BCWS	8	8	8	8	9	9	9	9	9	16	22	29
BCWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM BCWP	5	5	5	5	5	5	5	5	5	5	5	5
ACWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM ACWP	4	4	4	4	4	4	4	4	4	4	4	4
CV	1	1	1	1	1	1	1	1	1	1	1	1
SV	-3.	-3.	-3.	-4.	-4.	-4.	-4.	-4.	-4.	-11.	-17.	-24.
CPI	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23
SPI	0.61	0.6	0.59	0.58	0.57	0.56	0.55	0.54	0.53	0.31	0.22	0.17

7900 Integrated System (Gentile)		31JAN2014	28FEB2014	31MAR2014	30APR2014	31MAY2014	30JUN2014	31JUL2014	31AUG2014	30SEP2014	31OCT2014	30NOV2014	31DEC2014
	BCWS	13	15	6	0	0	0	0	0	15	0	0	0
	CUM BCWS	42	57	63	63	63	63	63	63	78	78	78	78
	BCWP	0	0	0	0	0	0	0	0	0	0	0	0
	CUM BCWP	5	5	5	5	5	5	5	5	5	5	5	5
	ACWP	0	0	0	0	0	0	0	0	0	0	0	0
	CUM ACWP	4	4	4	4	4	4	4	4	4	4	4	4
	CV	1	1	1	1	1	1	1	1	1	1	1	1
	SV	-37.	-52.	-58.	-58.	-58.	-58.	-58.	-59.	-73.	-73.	-73.	-73.
	CPI	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23
	SPI	0.12	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.06	0.06	0.06	0.06

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

cover Neutral Beam engineer's time to prepare for and participate in project cost and schedule reviews.
{NBI Project Support & Integration (Job 7300)}

WBS Element: 1.7.1.4 **WBS Level: 4**
WBS Title: Health Physics Support
Definition: This WBS element includes the effort necessary for continuous health physics (HP) support for the Neutral beamline decontamination, refurbishment, and relocation to the NTC as well as the HP support for equipment removal and relocations being accomplished under WBS 1.2.4.
{Health Physics Technical Support (Job 7400)}

Also included in this WBS element are the home office Health Physics efforts necessary to support the collection of radiological analyses of various environmental samples and bioassay samples, and the collection of analyses of data on the gamma radiation spectra of radioactive material at PPPL that are allocated to all Laboratory projects based on their usage of Health Physics staff.
{NSTX Upgrade Health Physics Allocations (Job 7700)}

WBS Element: 1.7.1.5 **WBS Level: 4**
WBS Title: Direct Allocations (Job 7710)
Definition: This WBS element includes the costs to cover Laboratory Engineering and Scientific Computing and Environmental Services that are allocated to all Laboratory projects based on their funding levels.
{NSTX Upgrade Direct Allocations (Job 7710)}

WBS Element: 1.7.2 **WBS Level: 3**
WBS Title: Project Physics
Definition: Project Physics includes the definition of requirements necessary to meet the overall NSTX mission and supporting objectives, physics analysis supporting the project's design and construction activities, and definition of R&D needs. In addition it includes the provision of hardware and software required for plasma control.
Project Physics is not included in the scope of the Upgrade Project.

WBS Element: 1.7.3 **WBS Level: 3**
WBS Title: Integrated Systems Tests
Definition: This element includes all of the activities associated with the support of development of all necessary procedures and documents to support the integrated tests, and to support performance of the pre-operational integrated system tests culminating in first plasma.

The WBS element includes Convening the NSTX Activity Certification Committee (ACC) for comprehensive review the upgrades. Prepare and make presentation to the PPPL ES&H Executive Safety Board for

issuance of appropriate Safety Certificate parameters for operation of NSTX with new enhanced operating capabilities; preparation of documentation (procedures) for safely integrating the upgrades for operations within NSTX safe operating parameters; working with NSTX Operations Group for the successful integration of the upgrades.
{Integrated Systems Test (Job 7900)}

WBS Element: 1.8 **WBS Level: 2**
WBS Title: Site Preparation and Assembly
Definition: Site preparation and torus assembly includes modifications to the existing NSTX Test Cell components and subsystems and the assembly and installation of all Torus Systems (WBS 1.1). Modifications to other PPPL facilities, components, and subsystems outside the NSTX Test Cell and the assembly and installation of non-torus components and subsystems are included in the individual components and subsystems.

WBS Element: 1.8.1 **WBS Level: 3**
WBS Title: Site Preparation
Definition: This WBS element includes construction of the NSTX machine platform and the modifications to the NSTX Test Cell. There are no activities in this WBS element as part of the NSTX Upgrade Project. NTC equipment removals, relocations and platform modifications necessary to support installation of the 2nd NBI are included in WBS element 1.2.4.2.

WBS Element: 1.8.2 **WBS Level: 3**
WBS Title: Torus Assembly and Construction
Definition: Torus Assembly and construction includes the assembly and installation of the NSTX torus, coils systems and all associated supports including construction management. This WBS element includes removal of equipment for clearance and accessibility, moving existing coils, cutting off existing supports mounted on the vacuum vessel and installing a new external cage support structure and reinstalling, testing and commissioning the equipment removed.
{Installation of the Coil Support System (Job 8200)}

Also included in this WBS element is the removal of the existing Center Stack and installation of the NSTX Upgraded Center Stack, followed by closing up the vacuum vessel, pumping down, leak checking, bakeout and machine area scrubs to be ready for Integrated System Testing.
{CS Removal & Re-Installation/Pumpdown/Bakeout (Job 8250)}

Work Approval Form (WAF)

Cost Center: 9417
Job Number: 7900
Job Title: Integrated System Test
Job Manager: Charles Gentile

Description: ACC Review and ISTP development & Implementation
Convene the NSTX Activity Certification Committee (ACC) for comprehensive review of NBI-2 and the new Center Stack upgrade. Prepare and make presentation to the PPPL ES&H Executive Safety Board for issuance of appropriate Safety Certificate parameters for opertion of NSTX with new enhanced operating capabilities.
Prepare documentation (procedure) for safely integrating NBI-2 and the new center stack for operations within NSTX safe operating parameters. Work with NSTX Operations Group for the successful intergration of NBI-2 and new CS sub-systems.
Participate in cost & schedueling reviews. Report on progress as required.

Schedule:

See Tab B or attached

Approvals:

7/27/2010
Job Manager

8/3/10
Project Manager

8/3/10
Engineering Department Head

Cost Center: 9417
Job N. er: 7900
Job Ti. Integrated System Test
Job Manager: Charles Gentile

USER INPUT TASKS AND DESCRIPTIONS — SCHEDULE *USER INPUT* — *Estimate (user input)*: FY10$K | HOURS

task numb	P3 cross ref (optinal)	TASK DESCRIPTION	Responsible	Duration in WORK DAYS	OPTIONAL Logical Pre-requisites (one task numbers in each column ,any order)	actual= A	M&S (41)	CREDIT CARD (43)	OTHER (39)	TRAVEL (35)	OVERTIME (31)	EA** EM (analysis engr)	EA** DM (Designer)	EC** EM (computing Engr)	EC** SM/TB (Computing Tech)	EE** EM (Elctr Engr)	EE** SM/TB (Elect Tech)	EM** EM (FO&M Engr)	EM** SM/TB (FO&M Tech)	FC** AM (P&C Officer)	DP** SB/TB (HP Tech)	R*** RM (Researcher)	Other:	Other:	Other:	Basis of Estimate and Names of req'd skills if known	Category
1		**Physics Requirements**																									
2																											
3		**Conceptual Design**																									
4		PREPARE WORK PLANNING FORM																									
5		Prep System Description																									
6		Prep System Requirements																									
7		R&D																									
8		Ananlysis																									
9		CDR																									
10																											
11		**Preliminary Design**																									
12		Thermal Analysis																									
13		Seismic Analysis																									
14		FMEA Analysis																									
15		Prepare NEPA Form																									
16		Update Cost & Schedule Estimate																									
17		Design Drawings																									
18		PDR Prep																									
19		CONDUCT PDR																									
20																											
21		**Final Design**																									
22		Disposition PDR Chits																									
23		Design Drawings																									
24		Update Analyses																									
25		Update Cost & Schedule Estimate																									
26		Prep Procurement Specs																									
27		FDR Prep																									
28		CONDUCT FDR																									
29																											
30																											
31		OTHER TASKS	Commence at Completion of C D 3																								
32		Conduct ACC Review of upgrades	C. Gentile													80		80									4-Previous NSTX Experience
33		Prepare NBI-2 & CS ISTP Test Procedure(s)	C. Gentile															120									4-Previous NSTX Experience
34		Participate in cost & scheduleing reviews	C. Gentile															40									4-Previous NSTX Experience
35		Perform ISTP (per NCSX 02)	NSTX Ops															80									4-Previous NSTX Experience
		TOTALS					$0	$0	$0	$0	$0	-	-	-	-	80	-	320	-	-	-	-	-	-	-		
		TOTAL Preliminary Cost Estimate ($k)=					$0	$0	$0	$0	$0	$0	$0	$0	$0	$14	$0	$53	$0	$0	$0	$0	$0	$0	$0		

The basis of estimate for the ACC review of these NSTX Upgrades as well as preparing test procedures and performing the ISTPs is based on prior experince of commissioning other upgrades to NSTX and performing their required ISTPs.
The logic used in developing the ISTP & ACC WAF is similiar to when we bring any new NSTX sub-system on-line (ie, LITER, CHI, etc.....). The sub-sytem cogs perform the PTP's. NSTX operations integrates the system into the project via the ISTP(s). Cost and time estimates are based on actual experience for running the past NSTX ACC reviews, and for bringing new sub-systems on board via NSTX-02 (+ the specific ISTP).
The risk to the project at the point of the ISTP is relatively low. The higher risk is with the sub-system cog's and their PTP's.

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

Cost Center: 9417

Job Number: 7900

Job Title: Integrated System Test

Job Manager: Charles Gentile

Uncertainty of the Estimate

	High	Medium	Low	Uncertainty Range (%)	Comments/Other Considerations
Design Maturity			X	20%	
Design Complexity		X		30%	

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	Conduct ACC review of NSTX upgrades	90%	Create puch list of outstanding items. Have sub-system cog address prior to making	ACC Review of NSTX Commissioning				
2	Prepare ISTP procedure(s) for Integration of NBI-2 and new CS into NSTX operations	90%	Using past experience with similar sub-system ISTP follow similar startup criteria	Integration of other sub-systems into NSTX Operations				
3	Commence ISTP's via NSTX-02 Startup Procedure	90%	Run NSTX 02 in accordance with NSTX Operations group	Experience from performing other ISTP's on NSTX				
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.

(3) **Likelihood of occurrence should be entered consistent with our risk classification methodology, i.e.**
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