Work Authorization Document

NSTX Upgrade Project

Control Account #:	2420	**Title:**	2nd NBI Sources
WBS	1.2.4	**Title:**	NB Injection
Period of Performance:	17 May 2010 through 01 August 2014		
Authorized Budget:	$1,094	**Control Account Manager:**	Cropper
Revision #:	0	**Revision Date:**	July-11

Authorized Work Description:

This WBS element includes the activities to refurbish three neutral beam ion sources for the 2nd Neutral beamline, as currently being performed for the installed Neutral beamline 1.

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.

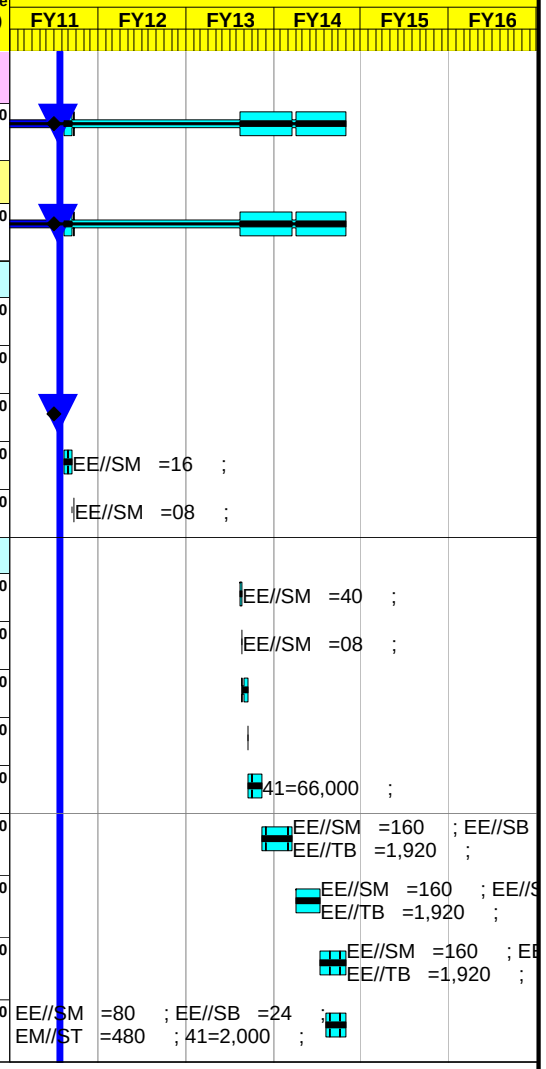
Control Account History

ECP#	Implement Date	Prior Budget	New Budget	Signature

Approvals	Name	Signature	Date
NSTX-U Project Manager	R. Strykowsky		
Control Account Manager	Cropper		
Functional Manager	T. Stevenson		

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		1,050	17MAY10A	17MAY10A	01AUG14	01AUG14	0	41	1,094,172.40		0.00	0.00
Job: 2420 - 2nd NBI Sources-CROPPER												
Subtotal		1,050	17MAY10A	17MAY10A	01AUG14	01AUG14	0	41	1,094,172.40		0.00	0.00
Design												
24200020	PDR Prep PPL	26	17MAY10A	17MAY10A	22JUN10A	22JUN10A	0		0.00	100	0.00	0.00
24200050	CONDUCT PDR	1	23JUN10A	23JUN10A	23JUN10A	23JUN10A	0		0.00	100	0.00	0.00
24200059	Peer Review	0			31MAR11	14APR11A	-10		0.00		0.00	0.00
24200060	FDR Prep PPL	24*	17MAY11	16MAY11*	14JUN11	17JUN11	-3	123	2,485.12		0.00	0.00
24200090	CONDUCT FDR	3	15JUN11	22JUN11*	15JUN11	24JUN11	-7	121	1,242.56		0.00	0.00
Procure, Fab & Assembly												
24200100	Prep Requisition and procurement package	5	15MAY13*	15MAY13*	21MAY13	21MAY13	0	20	6,956.40		0.00	0.00
24200110	SUBMIT REQ TO PROCUREMENT	1	22MAY13	22MAY13	22MAY13	22MAY13	0	20	1,391.28		0.00	0.00
24200120	Procurement lead time (1)	15	23MAY13	23MAY13	13JUN13	13JUN13	0	20	0.00		0.00	0.00
24200130	AWARD	1	14JUN13	14JUN13	14JUN13	14JUN13	0	20	0.00		0.00	0.00
24200150	Fabricate or delivery	40	17JUN13	17JUN13	13AUG13	13AUG13	0	20	87,120.00		0.00	0.00
24200160	Refurbish Source A	90	14AUG13	14AUG13	20DEC13	20DEC13	0	20	303,972.96		0.00	0.00
24200170	Refurbish Source B	70	02JAN14	02JAN14	09APR14	09APR14	0	20	307,667.20		0.00	0.00
24200180	Refurbish Source C	80	10APR14	10APR14	01AUG14	01AUG14	0	20	307,667.20		0.00	0.00
24200200	Build Probe tips (10 Long, 20 short)	60	08MAY14	08MAY14	01AUG14	01AUG14	0	41	75,669.68		0.00	0.00



Data Date 30APR11
Run Date 20MAY11 10:53

1105

NSTX UPGRADES
RESOURCE LOADED SCHEDULE
CD-2 Schedule
April 2011

Early Bar
Progress Bar
Critical Activity

2420 2nd NBI Sources (Cropper)		31JAN2011	28FEB2011	31MAR2011	30APR2011	31MAY2011	30JUN2011	31JUL2011	31AUG2011	30SEP2011	31OCT2011	30NOV2011	31DEC2011
	BCWS	0	0	0	0	1	2	0	0	0	0	0	0
	CUM BCWS	0	0	0	0	1	4	4	4	4	4	4	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	.	.	.	.	-1.	-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	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

2420 2nd NBI Sources (Cropper)		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	4	4	4	4	4	4	4	4	4	4	4	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	-4.	-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	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

2420 2nd NBI Sources (Cropper)		31JAN2013	28FEB2013	31MAR2013	30APR2013	31MAY2013	30JUN2013	31JUL2013	31AUG2013	30SEP2013	31OCT2013	30NOV2013	31DEC2013
	BCWS	0	0	0	0	8	21	48	60	67	76	69	50
	CUM BCWS	4	4	4	4	12	33	81	141	208	284	354	403
	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	-4.	-4.	-4.	-4.	-12.	-33.	-81.	-141.	-208.	-284.	-354.	-403.
	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

2420 2nd NBI Sources (Cropper)		31JAN2014	28FEB2014	31MAR2014	30APR2014	31MAY2014	30JUN2014	31JUL2014	31AUG2014	30SEP2014	31OCT2014	30NOV2014	31DEC2014
	BCWS	97	88	92	87	103	104	114	5	0	0	0	0
	CUM BCWS	500	588	680	767	870	975	1,089	1,094	1,094	1,094	1,094	1,094
	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	-500.	-588.	-680.	-767.	-870.	-975.	-1089.	-1094.	-1094.	-1094.	-1094.	-1094.
	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

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

thermal loading. Disruption loads on the ECH waveguide will be evaluated for the Center Stack Upgrade Fields and field transients. Discussions with heating system experts regarding the performance of the ECH system for the higher Center Stack Upgrade fields indicate that no modification to the resonant frequency or other operational characteristic for the system will require upgrade. Only disruption qualification is planned. No previous qualification has been identified, so the resources include creation of a new calculation – not a review of an existing calculation as is the case for ICRH.
{Electron Cyclotron Heating (Job 2300)}

WBS Element: 1.2.4 **WBS Level: 3**
WBS Title: Neutral Beam Injection (NBI)
Definition: The Neutral Beam Injection System Upgrade provides a second Neutral Beam as part of the NSTX Upgrade Project. The second NBI is identical to the one already installed on NSTX. An existing TFTR beam will be decontaminated, refurbished, and installed on NSTX. This WBS element includes the NBI source refurbishment; the TFTR beamline decontamination, refurbishment and relocation to the NSTX Test Cell; the 2nd NBI Services; the NBI armor modifications; the 2nd NBI Power, Controls and Instrumentation; the 2nd NBI Duct and vacuum vessel modifications; and the NSTX Test Cell equipment removals and relocations necessary to accommodate the 2nd NBI. Vacuum Pumping System Modifications necessary to accommodate the 2nd NBI are included in WBS element 1.3. NBI Management and Health Physics support are included in element WBS 1.7.

WBS Element: 1.2.4.2 **WBS Level: 4**
WBS Title: NBI Source Refurbishment
Definition: This WBS element includes the activities to refurbish three neutral beam ion sources for the 2nd Neutral beamline, as currently being performed for the installed Neutral beamline 1.
{Source Refurbishment (Job 2420)}

WBS Element: 1.2.4.3 **WBS Level: 4**
WBS Title: NSTX Beamline 2 Decontamination
Definition: This WBS element includes the disassembly and decontamination activities of a TFTR Neutral Beam beamline in preparation for beamline refurbishment and reuse as an NSTX upgrade.
{NSTX Beamline 2 Decontamination (Job 2430)}

WBS Element: 1.2.4.4 **WBS Level: 4**
WBS Title: NBI Beamline Refurbishment and Relocation
Definition: This WBS element includes refurbishment of a TFTR NBI and its relocation to the NSTX test cell.

Included in this WBS element are the activities necessary to refurbish a TFTR Neutral Beam beamline for use on NSTX. This scope includes

Work Approval Form (WAF)

Cost Center: 9418
Job Number: 2420
Job Title: Source Refurbishment
Job Manager: Mark Cropper
Rev 1 6/8/2010

Description:

This scope includes the activities to refurbish three neutral beam ion sources for BL2 just as we currently do for the installed BL1. The refurbishment tasks will follow established procedures that have been utilized for both TFTR and NSTX.

Schedule: Refer to Primavera Data-Base

Approvals:

Mark B. Cropper 7/20/10
Job Manager

T Simonson 7/20/10
Project Manager

8/3/10
Engineering Department Head

Cost Center:	9418		
Job Number:	2420		
Job Title:	Source Refurbishment		
Job Manager:	Mark Cropper		

Estimate (user input)

USER INPUT TASKS AND DESCRIPTIONS | SCHEDULE – USER INPUT | FY10$K | HOURS (priced at FY10 rates)

task numb	TASK DESCRIPTION	Responsible	DURATION IN WORK DAYS	Logical Pre-requisites (one task numbers in each column ,any order)	User Input Start Date (optional)	actual= A	M&S (41)	CREDIT CARD (43)	TRAVEL (35)	OVERTIME (31)	EA** EM (analysis engr)	EA** (Designer)	EE** EM (Elctr Engr)	EE** SM (Senior Electr Tech)	EE** SB (Electr Tech)	EE** TB (Electr Tech)	EM** EM (FO&M Engr)	EM** SM Senior Tech)	EM** SB (FO&M Tech)	EM** TB (FO&M Tech)	Contingency	Names of req'd skills if known	Basis of Estimate Category
P3 cross ref																							
1	Preliminary Design																						
2																							
3	PDR Prep PPL		2											16								cropper	Prior work
4	PDR Prep PU		2											16							5%	cropper	Prior work
5	PDR Prep DOE		2											16							5%	cropper	Prior work
6	CONDUCT PDR		1											8							5%	cropper	Prior work
7																							
8	Final Design																						
9																							
10	FDR Prep PPL		2											16							15%	cropper	Prior work
11	FDR Prep PU		2											16							15%	cropper	Prior work
12	FDR Prep DOE		2											16							15%	cropper	Prior work
13	FONDUCT PDR		1											1							15%	cropper	Prior work
14																							
15	Procurement																						
16	Item 1:																						
17	Prep Requisition and procurement package		5											40							15%	cropper	Prior work
18	SUBMIT REQ TO PROCUREMENT		1				$66							8							15%	cropper	Prior work
19	Procurement lead time (1)		15																				
20	AWARD		1																				
21	Fabricate or delivery		40																				
22																							
23	Fab/Assembly																						
24	Refurbish Source A		80		1/1/11									160	640	1,920					15%	cropper,bush,hynes,palmer,sabo	Prior work
25	Refurbish Source B		80	24										160	640	1,920					15%	cropper,bush,hynes,palmer,sabo	Prior work
26	Refurbish Source c		80	25										160	640	1,920					15%	cropper,bush,hynes,palmer,sabo	Prior work
28																							
29	Build Probe tips (10 Long, 20 short)		60				$2							80	24				480		30%	cropper,jurczynski	Prior work
30																							
33																							
	TOTALS						$68	$0	$0	$0	-	-	-	713	1,944	5,760	-	-	480	-			
	TOTAL Preliminary Cost Estimate ($k):		$962				$80	$0	$0	$0	$0	$0	$0	$107	$238	$481	$0	$0	$55	$0			

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

Cost Center:	9418
Job Number:	2420
Job Title:	Source Refurbishment
Job Manager:	Mark Cropper

Uncertainty of the Estimate

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

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								
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.

(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 Complexity

Design Maturity	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

Cost Center:	**9418**		
Job Number:	**2420**		
Job Title:	**Source Refurbishment**		
Job Manager:	**Mark Cropper**		

Materials and Subcontracts (M&S)

Description:		Amount	Basis of Estimate
Water Hose and Fittings		$ 38,000	past purchase
Mylar gaskets		$ 5,000	past purchase
Filament Chucks		$ 11,000	past purchase
O-rings		$ 5,000	past purchase
MOV's		$ 2,000	past purchase
Tubing fittings		$ 5,000	past purchase
Stainless Steel tubing		$ 500	past purchase
Alumina tube		$ 660	past purchase
Molybdenum rod		$ 500	past purchase
brase		$ 500	past purchase
	Total	$ 68,160	
			TOTALS

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.)
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