

## Work Authorization Document

### NSTX Upgrade Project

<b>Control Account #:</b>	1303	<b>Title:</b>	TF Joint Test Stand&Test
<b>WBS</b>	1.1.1.5	<b>Title:</b>	Magnet Systems

**Period of Performance:** 01 January 2010 through 25 April 2011

<b>Authorized Budget:</b>	\$353	<b>Control Account Manager:</b> Kozub
<b>Revision #:</b>	0	<b>Revision Date:</b> July-11

**Authorized Work Description:**

For the NSTX Upgrade Project a test stand to measure the required performance parameters on the new NSTX TF joint design will be designed and fabricated. Test parameter measurements and cyclic lifetime tests of the new TF joint will be performed and testing data will be compiled. The test stand will be modified for revised design configurations as needed and tests repeated with a final comprehensive test report generated that includes all test data.

**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	Kozub		
Functional Manager	L. Dudek		

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)	FY11	FY12	FY13	FY14	FY15	FY16
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# NSTX Upgrade Project

Subtotal		352	01JAN10A	01JAN10A	25APR11	25MAY11	-22	142	353,150.99		344,346.60	352,876.94						
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## Job: 1303 - R&D for TF Joint -KOZUB

Subtotal		352	01JAN10A	01JAN10A	25APR11	25MAY11	-22	142	353,150.99		344,346.60	352,876.94						
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### Material for CSU R&D Plan

1303-000A	1.2 Fatigue Test Verification - C18150 (TBD)	101*	01SEP10A	01SEP10A	19NOV10	31JAN11A	-43		0.00	100	0.00	0.00						
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### Single Flex Laminate CSU R&D Plan

1303-000B2	2.2 In-Place Bending Stiffness	100*	01SEP10A	01SEP10A	15DEC10	31JAN11A	-27		0.00	100	0.00	0.00						
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1303-000B3	2.3 Cyclic, Simulated Combined Tests	100*	01SEP10A	01SEP10A	15DEC10	31JAN11A	-27		0.00	100	0.00	0.00						
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### Full Flex Assembly CSU R&D Plan

1303-000C1	3.1 Selection Braze vs Solder Between Laminates	1	15SEP10A	15SEP10A	15SEP10A	15SEP10A	0		0.00	100	0.00	0.00						
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1303-000C2	3.2 Manufacture Joint w/Actual Hardware & Copper	100*	01OCT10*	03JAN11A	01OCT10	20MAY11	-157	126	0.00	50	0.00	0.00						
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1303-000C3	3.3 Materials for Testing	112*	15OCT10*	15OCT10A	15NOV10	30MAR11A	-89		0.00	100	0.00	0.00						
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1303-000C4	3.4 In-plane Bending Stiffness (use Joint Sample)	148*	15OCT10*	15OCT10A	15NOV10	20MAY11	-126	126	0.00	80	0.00	0.00						
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1303-000C5	3.5 Cyclic, Simulated Combine Test(Joint Sample)	148*	01OCT10*	15OCT10A	15DEC10	20MAY11	-106	126	0.00	60	0.00	0.00						
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1303-000C6	3.6 Contact Pressure Distribtn/Therml Joint Test	148*	15OCT10*	15OCT10A	15DEC10	20MAY11	-106	126	0.00	50	0.00	0.00						
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1303-000C7	Bellville Washer Test	63*		04JAN11A		31MAR11A	0		0.00	100	0.00	0.00						
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1303-000C8	T-Slot Tiles	43*		01FEB11A		30MAR11A	0		0.00	100	0.00	0.00						
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### FSW Trials CSU R&D Plan

1303-000D1	4.2 Verify C18150 can be Joint C10700 Conductors	1	10SEP10A	10SEP10A	10SEP10A	10SEP10A	0		0.00	100	0.00	0.00						
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### Joint Inserts CSU R&D Plan

1303-000E	5.1 Tap-Lok Insert Pullout Strength-Static/Fatig	114*	22NOV10*	13OCT10A	05JAN11	30MAR11A	-60		0.00	100	0.00	0.00						
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### Insulation Bond Test CSU R&D Plan

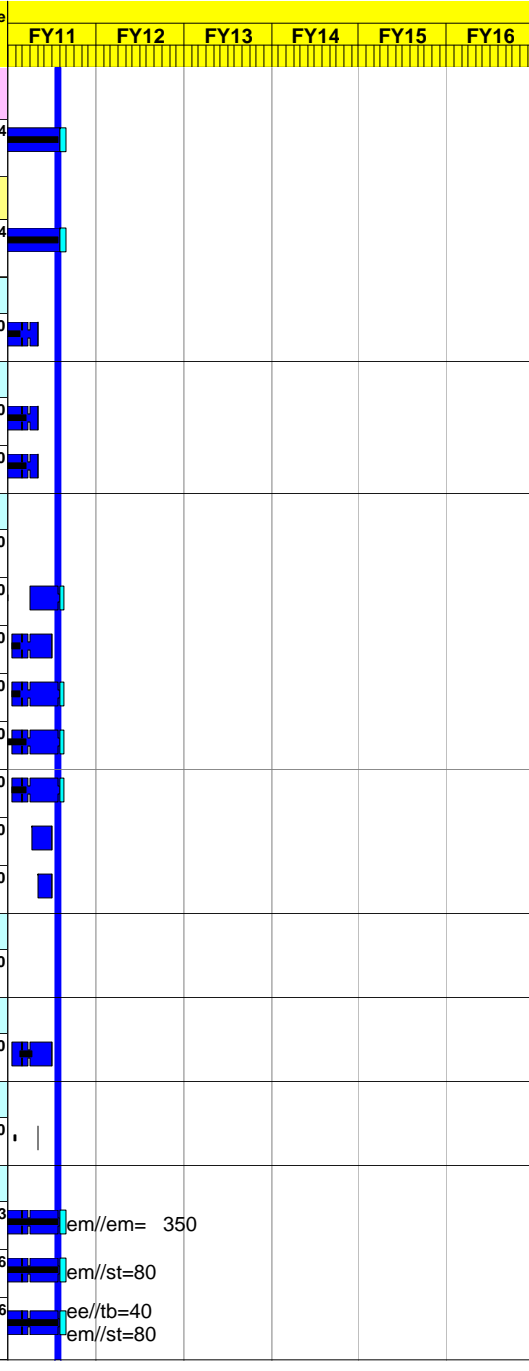
1303-000F	X-6.1 Verif Shear Bond Strength Copper/Epoxy/Ins	1	29OCT10*	31JAN11A	29OCT10	31JAN11A	-58		0.00	100	0.00	0.00						
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### Testing

1303-001	Test Engineering Design and Analysis	267*	01MAY10A	01MAY10A	25APR11	25MAY11	-22	142	53,197.52	91	48,231.94	53,002.13						
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1303-002	Materials Testing	267*	01MAY10A	01MAY10A	25APR11	25MAY11	-22	142	7,669.38	90	6,880.82	7,645.36						
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1303-003	Component Testing	267*	01MAY10A	01MAY10A	25APR11	25MAY11	-22	142	10,955.68	90	9,832.73	10,925.26						
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Data Date: 30APR11 1105  
 Run Date: 20MAY11 10:49

NSTX UPGRADES  
 RESOURCE LOADED SCHEDULE  
 CD-2 Schedule  
 April 2011

Sheet 1 of 2

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)	FY11 FY12 FY13 FY14 FY15 FY16						
1303-004	Assembly Testing	182*	01SEP10A	01SEP10A	25APR11	25MAY11	-22	142	19,055.03	90	17,127.73	19,030.81	ee//tb=40 em//st=160						
1303-005	Model Fabrication	245*	01MAY10A	01MAY10A	31AUG10A	31AUG10A	0		0.00	100	0.00	0.00							
1303-011	Testing Design Support and M&S	160*	01OCT10*	01OCT10A	25APR11	30MAR11A	18		212,541.38	100	212,541.38	212,541.38	EM/EM = 578 hrs; EA/DM=160hrs; M&S = \$80,000						
FY101303	FY10 Actual Cost	85	01JAN10A	01JAN10A	30APR10A	30APR10A	0		28,278.00	100	28,278.00	28,278.00							
FY101303A	FY10 Actual Cost	110	03MAY10A	03MAY10A	30SEP10A	30SEP10A	0		21,454.00	100	21,454.00	21,454.00	81=19,454						







## 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			<b>NSTX UPGRADE PROJECT</b>
	<b>1.1</b>		<b>Torus Systems</b>
		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
	<b>1.2</b>		<b>Plasma Heating and Current Drive Systems</b>
		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)
	<b>1.3</b>		<b>Auxiliary Systems</b>
		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
	<b>1.4</b>		<b>Plasma Diagnostics</b>
		1.4.1	Plasma Diagnostics
	<b>1.5</b>		<b>Power Systems</b>
		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
	<b>1.6</b>		<b>Central Instrumentation and Controls (I&amp;C)</b>
		1.6.1	Control System
		1.6.2	Data Acquisition System
	<b>1.7</b>		<b>Project Support &amp; Integration</b>
		1.7.1	Project Management and Integration
		1.7.2	Project Physics
		1.7.3	Integrated Systems Tests
	<b>1.8</b>		<b>Site Preparation and Assembly</b>
		1.8.1	Site Preparation
		1.8.2	Torus Assembly and Construction

## Annex I – WBS Dictionary

**WBS Element: 1.1.3.3**

**WBS Level: 4**

**WBS Title: Center Stack Assembly (CSA)**

Definition: The CSA consists of the inner TF coil legs, the OH solenoid, the shaping coils, and the center stack casing. Also included in this WBS element are the TF coil joint (flex bus assembly) and the ceramic break assembly. The scope of this WBS element includes the design, analysis, prototypes (as required), procurement activities, fabrication and assembly of the Center Stack.

**WBS Element: 1.1.3.3.1**

**WBS Level: 5**

**WBS Title: Center Stack - TF Inner Legs/Bundle**

Definition: The TF inner leg subsystem consists of the new coil sections that will make up the TF inner bore and bundle. Also included in the scope of this WBS element is the TF coil joint (flex bus assembly) and testing of the new TF coil joint design.

For the NSTX Upgrade Project a new TF Inner Leg will be fabricated. This WBS element includes the design of the TF Bundle, the TF flex bus and flex bus supports and includes all analytical and CAD design efforts for these components. It also includes the early procurement of the TF conductor [80 lengths] and procurement of the TF flex bus and supports. It does not include the procurement/fabrication of the Inner TF bundle, which is included as part of the OH procurement in WBS 1.1.3.3.2.

**{Inner Toroidal Field Bundle (Job 1304)}**

For the NSTX Upgrade Project a test stand to measure the required performance parameters on the new NSTX TF joint design will be designed and fabricated. Test parameter measurements and cyclic lifetime tests of the new TF joint will be performed and testing data will be compiled. The test stand will be modified for revised design configurations as needed and tests repeated with a final comprehensive test report generated that includes all test data.

**{TF Joint Stand & Performance Test (Job 1303)}**

**WBS Element: 1.1.3.3.2**

**WBS Level: 5**

**WBS Title: Ohmic Heating Solenoid**

Definition: The ohmic heating solenoid subsystem consists of the new coils that will make up the center solenoid. This WBS element includes the design, analysis, prototypes (as required), procurement activities and fabrication.

For the NSTX Upgrade a new OH Solenoid will be fabricated. This WBS element includes the design & fabrication of a new OH solenoid and associated components including a Belleville washer spring assembly and support structures for the NSTX upgrades. It also includes all analytical & CAD design efforts. Includes advance procurement of the copper conductor and co-wound [glass/Kapton] insulation. Also includes the procurement of the Micro-therm insulation, conductive paint.

Includes the procurement and engineering oversight for the combined OH



## Work Approval Form (WAF)

**Cost Center:** 9417  
**Job Number:** 1303  
**Job Title:** TF Joint Test Stand & Performance Test  
**Job Manager:** Tom Kozub

**Description:**

Design and fabrication of a test stand to measure the required performance parameters on the new NSTX TF joint design. Perform test parameter measurements and cyclic lifetime tests as required. Compile and report testing data. Modify test stand configuration for revised design configurations as needed. Repeat tests for revised design configurations as needed. Compile comprehensive final test report including all test data.

**Schedule:**

Refer to the Primavera Data-Base

**Approvals:**

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Job Manager

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Project Manager

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Engineering Department Head





<b>Job Number:</b>	1303
<b>Job Title:</b>	TF Joint Test Stand & Performance Test
<b>Job Manager:</b>	Tom Kozub

<b>USER INPUT TASKS AND DESCRIPTIONS</b>		<b>SCHEDULE</b>				<b>Estimate (user input)</b>										<b>Category</b>				
		<b>DURATI ON in WOR K DAYS</b>	<b>OPTIONAL Logical Pre- requisites (one task numbers in each column, any order)</b>	<b>HOURS(-priced at FY10 rates)</b>																
<b>TASK DESCRIPTION</b>	<b>Responsible</b>				M&S (41)	CREDIT CARD (43)	OTHER (39)	TRAVEL (35)	OVERTIME (31)	EA** EM (analysis engr)	EA** DM (Designer Eng)	EC** EM (computing Eng)	EC** SM/TB (Computing Tech)	EE** EM (Ectr Engr)	EE** SM/TB (Ectr Tech)	EM** EM (FO&M Engr)	EM** SM/TB (FO&M Tech)	FC** AM (P&C Officer)	DP** SB/TB (HP Tech)	
17	Design Drawings			9						40						40				Prior NSTX Center Stack Testing - Test Engineer & Designer Draftsman 2,4
18	PDR Prep			9												40				Prior NSTX Center Stack Testing - Test Engineer 2,4
19	CONDUCT PDR			16	17	18										8				Prior NSTX Center Stack Testing - Test Engineer 2,4
20	Final Design																			
22	Disposition PDR Chits			19												24				Prior NSTX Center Stack Testing - Test Engineer 2,4
23	Design Drawings			22																Prior NSTX Center Stack Testing - Test Engineer & Designer Draftsman 2,4
24	Update Analysis										80									
25	Update Cost & Schedule Estimate			22																Prior NSTX Center Stack Testing - Test Engineer 2,4
26	Prep Procurement Specs			22												16				Prior NSTX Center Stack Testing - Test Engineer 2,4
27	FDR Prep			22												40				Prior NSTX Center Stack Testing - Test Engineer 2,4
28	CONDUCT FDR			24	25	26	27									8				Prior NSTX Center Stack Testing - Test Engineer 2,4
29																				
30	Procurement																			
31	Item 1:																			
32	Prep Requisition and procurement package																			

Job Nui		1303		TF Joint Test Stand & Performance Test		Tom Kozub														
Job Title:																				
Job Manager:																				
<u>USER INPUT TASKS AND DESCRIPTIONS</u>				<u>SCHEDULE</u>																
				<u>USER INPUT</u>																
task	TASK DESCRIPTION	Responsible	DURATI ON in WOR K 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 eng)	EA** DM (Designer)	EC** EM (computing Engr)													
				EC** SM/TB (Computing Tech)	EE** EM (Ectr Engr)	EE** SM/TB (Ectr Tech)	EM** EM (F&M Engr)													
				EM** SM/TB (F&M Engr)	EM** SM/TB (F&M Tech)	FC** AM (P&C Officer)	DP** SB/TR (HP Tech)													
				Basis of Estimate and Names of req'd skills if known																
				Category																
33	SUBMIT REQ TO PROCUREMENT																			
34	Procurement lead time (1)																			
35	AWARD																			
36	Fabricate or delivery																			
37	Item 2:																			
38	Prep Requisition and procurement package																			
39	SUBMIT REQ TO PROCUREMENT																			
40	Procurement lead time (1)																			
41	AWARD																			
42	Fabricate or delivery																			
43																				
44	Fab/Assembly																			
45	Fab/Assy Procedure		20	28																
46	Shop Fabrication		50	45																
47	Assembly		30	46																
48																				
49	Installation																			
50	Installation Procedure																			
51	Machine Installation		30	47																
52	PTP Testing		60	51																
53																				

Job Number: 1303  
 Job Title: TF Joint Test Stand & Performance Test  
 Job Manager: Tom Kozub

task	TASK DESCRIPTION	Responsible	DURATI ON in WOR K DAYS	SCHEDULE USER INPUT	Estimate (user input)		Basis of Estimate and Names of req'd skills if known	Category
					FY10\$K	HOURS(priced at FY10 rates)		
54	OT/Final Report & Presentation		15	52	40	120	Center Stack	2,4
55								
56								

TOTALS					160	928	620	
TOTAL Preliminary Cost Estimate (\$k)=			\$335					

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 Experience (e.g., TFTR, NSTX, PLT, etc.)
- 5 - Prototype Data/Test Results
- 6 - Catalogue Price/Vendor Quote
- 7 - Placed Contracts
- 8 - Actual experience for NCSX Work
- 9 - Other







