Work Authorization Document

NSTX Upgrade Project

Control Account #:	8250	**Title:**	Remove/Install Centerstack
WBS	1.8.2	**Title:**	Site Preparation and Torus Assembly
Period of Performance:	01 October 2012 through 22 August 2014		
Authorized Budget:	$1,174	**Control Account Manager:**	Perry
Revision #:	0	**Revision Date:**	July-11

Authorized Work Description:

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.

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.

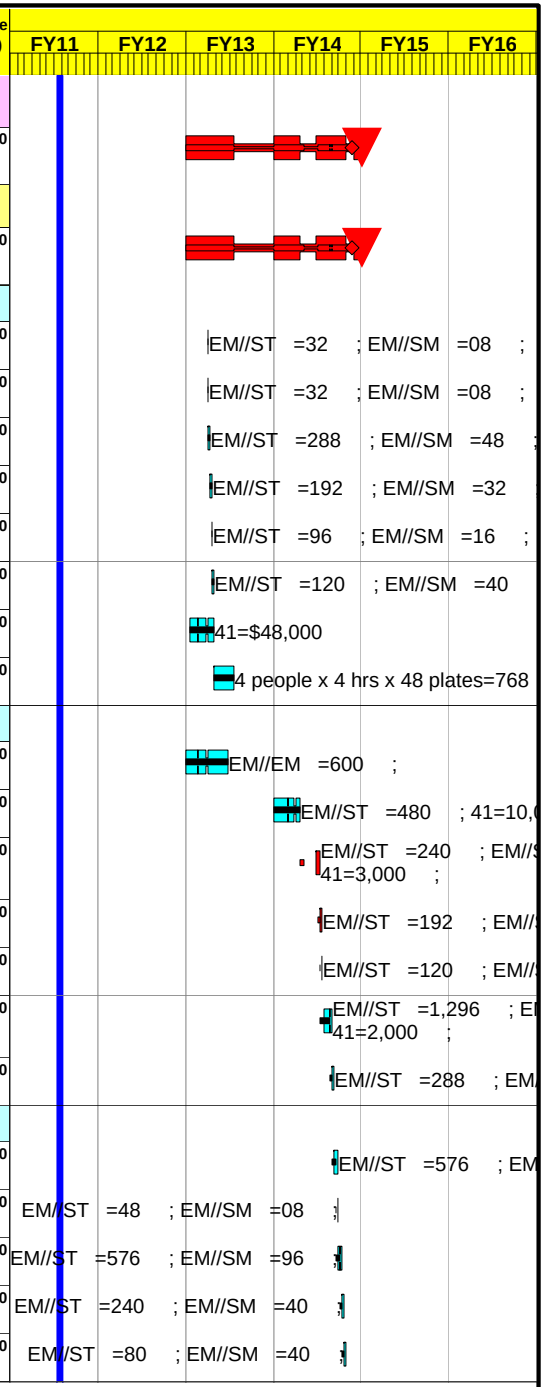
Control Account History

ECP#	Implement Date	Prior Budget	New Budget	Signature

Approvals	Name	Signature	Date
NSTX-U Project Manager	R. Strykowsky		
Control Account Manager	Perry		
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		500	01OCT12	01OCT12	22AUG14	06OCT14	-30	-19	1,173,571.12		0.00	0.00
Job: 8250 - Remove/Install Centerstack-PERRY												
Subtotal		500	01OCT12	01OCT12	22AUG14	06OCT14	-30	-19	1,173,571.12		0.00	0.00
Remove Old Centerstack												
8250-101	Disconnect Hoses	1	02JAN13*	02JAN13*	02JAN13	02JAN13	0	161	4,967.20		0.00	0.00
8250-105	Remove umbrella lid (top and bottom)	1	03JAN13	03JAN13	03JAN13	03JAN13	0	161	4,967.20		0.00	0.00
8250-109	Remove flex bus (top and bottom)	6	04JAN13	04JAN13	11JAN13	11JAN13	0	161	40,466.88		0.00	0.00
8250-113	Support lower support structure	4	14JAN13	14JAN13	17JAN13	17JAN13	0	161	26,977.92		0.00	0.00
8250-117	lift old centerstack	2	18JAN13	18JAN13	21JAN13	21JAN13	0	161	13,488.96		0.00	0.00
8250-121	Remove old centerstack pedestal	5	22JAN13	22JAN13	28JAN13	28JAN13	0	212	20,392.80		0.00	0.00
8250-122	Purchase passive plate bolts	65	17OCT12	17OCT12	28JAN13	28JAN13	0	212	63,360.00		0.00	0.00
8250-122A	Replace mountiung bolts for passive plates	60	29JAN13	29JAN13	22APR13	22APR13	0	212	85,309.44		0.00	0.00
Install New Centerstack												
8250-123	Dsgn Lift Fixture for new centerstack pedestal	120	01OCT12*	01OCT12*	28MAR13	28MAR13	0	159	106,284.00		0.00	0.00
8250-124	Fab Lift Fixture for new centerstack pedestal	70	01OCT13*	01OCT13*	20JAN14	20JAN14	0	31	68,623.20		0.00	0.00
8250-125	Install new centerstack pedestal	10	21JAN14	01APR14	03FEB14	14APR14	-50	-19	46,186.00		0.00	0.00
8250-129	Lift in new centerstack (2 times)	4	04APR14	15APR14	09APR14	18APR14	-7	-19	27,879.04		0.00	0.00
8250-133	Check vacuum seals	5	10APR14	21APR14	16APR14	25APR14	-7	6	21,068.00		0.00	0.00
8250-137	Install new flex bus (3 times w/2 re-machinings)	27	17APR14	28APR14	23MAY14	04JUN14	-7	6	190,883.52		0.00	0.00
8250-141	Install new umbrella (3 times w/2 re-machinings)	6	27MAY14	05JUN14	03JUN14	12JUN14	-7	6	41,818.56		0.00	0.00
Close Vessel and Pumpdown												
8250-145	Clean, Photo, Close VV	9	06JUN14	13JUN14	18JUN14	25JUN14	-5	6	79,264.80		0.00	0.00
8250-149	Pumpdown	1	19JUN14	26JUN14	19JUN14	26JUN14	-5	6	6,969.76		0.00	0.00
8250-153	Leak check	12	20JUN14	27JUN14	08JUL14	15JUL14	-5	6	83,637.12		0.00	0.00
8250-157	Setup for Bakeout	5	09JUL14	16JUL14	15JUL14	22JUL14	-5	6	34,848.80		0.00	0.00
8250-161	Rayleigh/Raman Scattering	5	16JUL14	23JUL14	22JUL14	29JUL14	-5	6	16,474.40		0.00	0.00



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

Sheet 1 of 2

Early Bar
Progress Bar
Critical Activity

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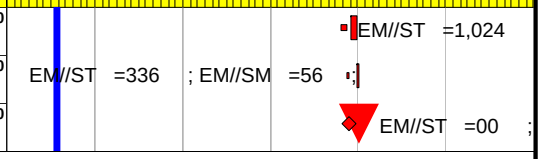
Activity ID	Activity Description	Work Days	BASELINE START	Forecast Start	BASELINE FINISH	Forecast Finish	Schedule Slip (Days)	Total Float	Budgeted Cost	PPCT	Earned value cost (BCWP)	Planned value cost (BCWS)
8250-165	Bakeout	16	23JUL14	04SEP14	13AUG14	25SEP14	-30	-19	140,915.20		0.00	0.00
8250-169	Recover from bakeout & scrub	7	14AUG14	26SEP14	22AUG14	06OCT14	-30	-19	48,788.32		0.00	0.00
8250-173	Ready for ISTP	0			22AUG14	06OCT14	-30	-19	0.00		0.00	0.00



8250 Remove/Install Centerstack (Perry)	START	28FEB2009	31MAR2009	30APR2009	31MAY2009	30JUN2009	31JUL2009	31AUG2009	30SEP2009	31OCT2009	30NOV2009	31DEC2009
BCWS	0	0	0	0	0	0	0	0	0	0	0	0
CUM BCWS	0	0	0	0	0	0	0	0	0	0	0	0
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	.	.	.	.	.	.	.	.	.	.	.	.
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

8250 Remove/Install Centerstack (Perry)	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	0	0	0	0	0	0	0	0	0	0	0	0
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	.	.	.	.	.	.	.	.	.	.	.	.
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

8250 Remove/Install Centerstack (Perry)	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	0	0	0	0	0	0	0	0	0	0	0	0
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	.	.	.	.	.	.	.	.	.	.	.	.
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

8250 Remove/Install Centerstack (Perry)	31JAN2012	29FEB2012	31MAR2012	30APR2012	31MAY2012	30JUN2012	31JUL2012	31AUG2012	30SEP2012	31OCT2012	30NOV2012	31DEC2012
BCWS	0	0	0	0	0	0	0	0	0	28	37	35
CUM BCWS	0	0	0	0	0	0	0	0	0	28	65	101
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	.	.	.	.	.	.	.	.	.	-28.	-65.	-101.
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

8250 Remove/Install Centerstack (Perry)	31JAN2013	28FEB2013	31MAR2013	30APR2013	31MAY2013	30JUN2013	31JUL2013	31AUG2013	30SEP2013	31OCT2013	30NOV2013	31DEC2013
BCWS	152	45	46	23	0	0	0	0	0	20	18	19
CUM BCWS	252	297	343	366	366	366	366	366	366	386	404	423
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	-252.	-297.	-343.	-366.	-366.	-366.	-366.	-366.	-366.	-386.	-404.	-423.
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

8250 Remove/Install Centerstack (Perry)	31JAN2014	28FEB2014	31MAR2014	30APR2014	31MAY2014	30JUN2014	31JUL2014	31AUG2014	30SEP2014	31OCT2014	30NOV2014	31DEC2014
BCWS	54	5	0	120	148	145	152	128	0	0	0	0
CUM BCWS	476	481	481	601	749	894	1,046	1,174	1,174	1,174	1,174	1,174
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	-476.	-481.	-481.	-601.	-749.	-894.	-1046.	-1174.	-1174.	-1174.	-1174.	-1174.
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

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: 8250

Job Title: Centerstack Removal & Re-installation/Pumpdown/Bakeout
Job Manager: Erik D. Perry

Description:

The scope of this job includes the removal of the existing centerstack and installation of the upgraded centerstack. This also includes the vessel closing, pumpdown and leak check, bakeout and scrub so that NSTX is ready to start ISTPs.

Schedule:

Refer to Primavera Data-Base

Approvals:

Erik D. Perry 7/20/10
Job Manager

8/3/10
Project Manager

Engineering Department Head

Job Number: 8250
Job Title: Centerstack Removal & Re-installation/Pumpdown/Bakeo
Job Manager: Erik D. Perry

task numb	P3 cross ref (optinal)	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)	OTHER (39)	TRAVEL (35)	OVERTIME (31)	EA** EM (analysis engr)	EA** SB(Designer)	EC** EM (computing Engr)	EC** SB (Computing Tech)	EC** TB (Computing Tech)	EE** EM (Electr 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)	LP** TB (HP Tech)	FC** AM (P&C Officer)	Contingency	Names of req'd skills if known	Basis of Estimate Category
				SCHEDULE						FY10$K					HOURS (priced at FY10 rates)																	
		USER INPUT TASKS AND DESCRIPTIONS		USER INPUT																												
1		Installation																														
2		Installation Procedure Review	Winston	3																												
3																																
4							Crew	Days																								
5							Size																									
6																																
7		Remove Old Centerstack																														
8		Disconnect hoses					4	1																8		32			15%		2-Experience
9		Remove umbrella lid (top and bottom)					4	1																8		32			15%		2-Experience
10		Remove flex bus (top and bottom)					6	6																48		288			15%		2-Experience
11		Support lower support structure					6	4																32		192			15%		2-Experience
12		Lift centerstack					6	2																16		96			15%		2-Experience
13		Remove old centerstack pedestal					3	5																40		120			15%		2-Experience
14																																
15		Install New Centerstack																														
16		Install new centerstack pedestal					3	10		$3														80		240			15%		2-Experience
17		Lift in new centerstack (2 times)					6	4																32		192			15%		2-Experience
18		Check vacuum seals					3	5																40		120			15%		2-Experience
19		Install new flex bus (3 times, w/ 2 re-machinings)					6	27		$2														216		1,296			15%		2-Experience
20		Install new umbrella lid (3 times w/ 2 re-machinings)					6	6																48		288			15%		2-Experience
21																																
22		Close Vessel and Pumpdown																														
23		Clean, Photo, Close					8	9																72		576			15%		2-Experience
24		Pumpdown					6	1																8		48			15%		2-Experience
25		Leak check					6	12																96		576			15%		2-Experience
26		Setup for Bakeout					6	5																40		240			15%		2-Experience
27		Rayleigh / Raman Scattering					2	5																40		80			15%		2-Experience
28		Bakeout					8	16																128		1,024			15%		2-Experience
29		Recover from bakeout and scrub					6	7																56		336			15%		2-Experience
30		Ready for ISTP																														
31																																
32																																
33																																
34																																
		TOTALS								$5	$0	$0	$0	$0										1,008	-	5,776	-	-			
		TOTAL Preliminary Cost Estimate ($K)=		$671						$6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$150	$0	$515	$0	$0			

Estimate (user input)

Basis of Estimate for Duration of activities and crew sizes is past experience developed from prior removal and re-installation of the NSTX CenterStack

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:	9417
Job Number:	8250
Job Title:	Centerstack Removal & Re-installation/Pumpdown/Bakeout
Job Manager:	Erik D. Perry

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	Vacuum Seals don't pass leakcheck	VU	Lift centerstack out, rework seals, re-install centerstack	Prior experience	28	56	1	2
2	Flex bus requires more than two fit-ups/ reworks prior to final installation	U	Repeat "remove, rework, re-install"	Prior experience	63	189	2	6
3	Umbrella lids require more than two fit-ups/ reworks prior to final installation	U	Repeat "remove, rework, re-install"	Prior experience	14	42	1	2
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 Recommended

Cost Center:	9417							
Job Number:	8250							
Job Title:	Centerstack Removal & Re-installation/Pumpdown/Bakeout							
Job Manager:	Erik D. Perry							
Materials and Subcontracts (M&S)					**Basis of Estimate**			
Description:								

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

TOTALS