

Work Authorization Document

NSTX Upgrade Project

Control Account #:	1307	Title:	CS Casing Assembly
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WBS	1.1.9	Title:	Magnet Systems
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Period of Performance: 01 December 2009 through 06 January 2014

Authorized Budget:	\$904	Control Account Manager: Chrzanowski
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Revision #: 0	Revision Date: July-11
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Authorized Work Description:

This WBS element includes the design and fabrication of the Center Stack casing and ceramic break assembly for the upgraded Center Stack as well as the assembly of the new Center Stack.

The Center Stack Casing effort includes analysis and CAD design for the casing components; the procurement of the Inconel tubing, forgings, bellows and organ pipes; the fabrication of Center Stack support legs; the procurement/fabrication of a new ceramic break assembly; the in-house assembly of the casing components; and mounting of the PF1A and PF1B structure/coils to the casing.

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	Chrzanowski		
Functional Manager	P. Heitzenroeder		

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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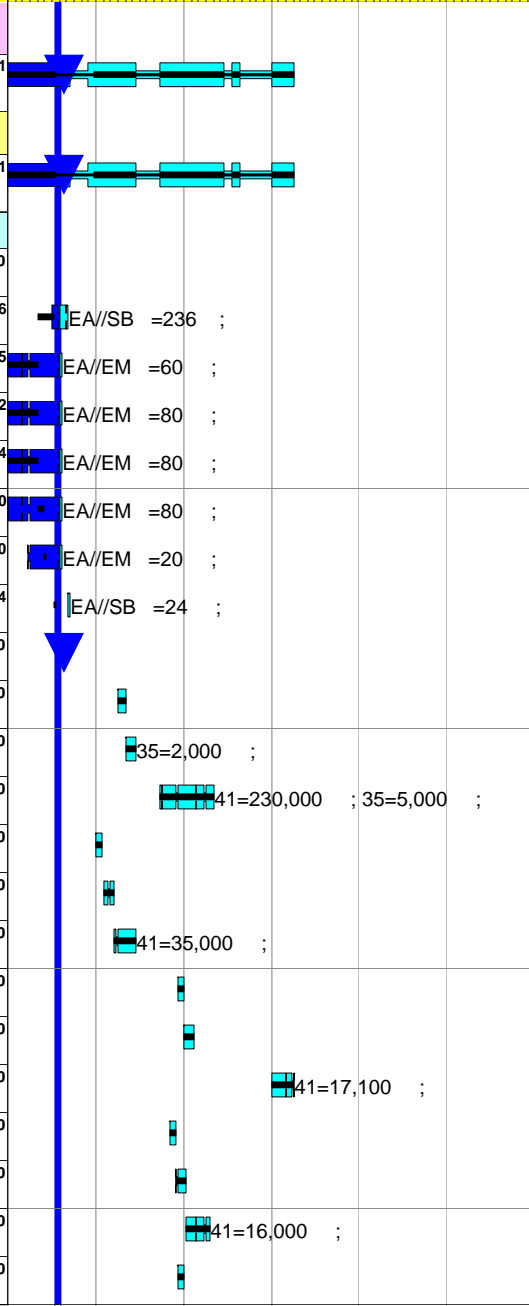
NSTX Upgrade Project

Subtotal		1,015	01DEC09A	01DEC09A	06JAN14	06JAN14	0	51	904,627.54		139,894.87	167,190.11						
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Job: 1307 - CS Casing Assembly -CHRZANOWSKI

Subtotal		1,015	01DEC09A	01DEC09A	06JAN14	06JAN14	0	51	904,627.54		139,894.87	167,190.11						
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1307-1010	Complete CAD Detail & Assy Drawings (Prelim)	104	03MAY10A	03MAY10A	31AUG10A	31AUG10A	0		0.00	100	0.00	0.00						
1307-1010A	Complete CAD Detail & Assy Drawings (Final)	48*	01FEB11*	31MAR11A	07APR11	07JUN11	-42	126	29,478.76	50	14,739.38	29,478.76						
1307-1020	Complete Bellow & Ceramic Break Analysis	223*	24JUN10A	24JUN10A	31JAN11	16MAY11	-75	141	11,167.41	85	9,322.84	10,968.05						
1307-1030	Complete Halo Loading	208*	16JUL10A	16JUL10A	31JAN11	16MAY11	-75	141	14,974.30	85	12,517.20	14,726.12						
1307-1040	Complete-Maintain Heat Balance Cooling Calcs	188*	13AUG10A	13AUG10A	31JAN11	16MAY11	-75	141	15,107.82	85	12,668.69	14,904.34						
1307-1050	Integrate Thermal, Halo, Dsir Loads into Calcs	153*	01FEB11	04OCT10A	28FEB11	16MAY11	-55	141	15,414.40	82	12,639.81	15,414.40						
1307-1060	Fatigue Assessments	100*	01MAR11	20DEC10A	07MAR11	16MAY11	-50	141	3,853.60	82	3,159.95	3,853.60						
1307-1150	Prepare for FDR	8*	08APR11	08JUN11	15APR11	17JUN11	-44	126	2,997.84		0.00	2,997.84						
1307-1155	CS Casing Assembly - Peer review	0				18MAY11*	0	147	0.00		0.00	0.00						
1307-2010	Prep CS Casing SOW & Requisition	20	03JAN12*	03JAN12*	30JAN12	30JAN12	0	198	0.00		0.00	0.00						
1307-2020	Bid/Award CS Casing Contract	30	31JAN12	31JAN12	12MAR12	12MAR12	0	198	2,580.00		0.00	0.00						
1307-2030	Fabricate CS Casing	150	25JUN12*	25JUN12*	04FEB13	04FEB13	0	125	307,031.33		0.00	0.00						
1307-2040	Spec/Requisition Inconel Bellows	20	03OCT11*	03OCT11*	28OCT11	28OCT11	0	196	0.00		0.00	0.00						
1307-2050	Bid/Award Inconel Bellows	30	31OCT11	31OCT11	13DEC11	13DEC11	0	196	0.00		0.00	0.00						
1307-2060	Fab & Deliver Inconel Bellows	60	14DEC11	14DEC11	14MAR12	14MAR12	0	196	45,150.00		0.00	0.00						
1307-2070	Spec/Requisition Rotatable Flanges	20	04SEP12*	04SEP12*	01OCT12	01OCT12	0	268	0.00		0.00	0.00						
1307-2080	Bid/Award Rotatable Flanges	30	02OCT12	02OCT12	12NOV12	12NOV12	0	268	0.00		0.00	0.00						
1307-2090	Fab & Deliver Rotatable Flanges	60	01OCT13*	01OCT13*	06JAN14	06JAN14	0	51	23,085.00		0.00	0.00						
1307-2100	Spec/Requisition CHI Copper Leads U&L	20	01AUG12*	01AUG12*	28AUG12	28AUG12	0	170	0.00		0.00	0.00						
1307-2110	Bid/Award CHI Copper Leads	30	29AUG12	29AUG12	10OCT12	10OCT12	0	170	0.00		0.00	0.00						
1307-2120	Fab & Deliver CHI copper Leads U&L	60	11OCT12	11OCT12	15JAN13	15JAN13	0	170	21,120.00		0.00	0.00						
1307-2130	Spec/Requisition CS Casing Support Structure	20	04SEP12*	04SEP12*	01OCT12	01OCT12	0	238	0.00		0.00	0.00						



Data Date: 30APR11 1105
 Run Date: 20MAY11 10:51
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NSTX UPGRADES
 RESOURCE LOADED SCHEDULE
 CD-2 Schedule
 April 2011

Sheet 1 of 2
 Legend:
 Cyan bar: Early Bar
 Blue bar: Progress Bar
 Red 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
1307-2140	Bid/Award CS Casing Support Structure	30	02OCT12	02OCT12	12NOV12	12NOV12	0	238	0.00		0.00	0.00						
1307-2150	Fab & Deliver CS Casing Support Structure	80	13NOV12	13NOV12	15MAR13	15MAR13	0	238	39,600.00		0.00	0.00						
1307-2160	Spec/Requisition Weld Material	20	26SEP11*	01SEP11*	21OCT11	29SEP11	16	217	0.00		0.00	0.00						
1307-2170	Bid/Award Weld Material	30	24OCT11	30SEP11	06DEC11	10NOV11	16	217	0.00		0.00	0.00						
1307-2180	Fab & Deliver Weld Material	60	07DEC11	11NOV11	07MAR12	14FEB12	16	217	7,830.64		0.00	0.00						
1307-2190	Spec/Requisition Misc M&S	20	26SEP11*	01SEP11*	21OCT11	29SEP11	16	217	0.00		0.00	0.00						
1307-2200	Bid/Award Misc M&S	30	24OCT11	30SEP11	06DEC11	10NOV11	16	217	0.00		0.00	0.00						
1307-2210	Fab & deliver Misc M&S	60	07DEC11	11NOV11	07MAR12	14FEB12	16	217	9,211.28		0.00	0.00						
1307-2220	Spec/requisition Ceramic Insulators	20	04SEP12*	04SEP12*	01OCT12	01OCT12	0	268	0.00		0.00	0.00						
1307-2230	Bid/Award Creamic Insulators	30	02OCT12	02OCT12	12NOV12	12NOV12	0	268	0.00		0.00	0.00						
1307-2240	Fab & Deliver Ceramic Insulators	60	13NOV12	13NOV12	15FEB13	15FEB13	0	268	105,600.00		0.00	0.00						
1307-2250	Spec/Requisition CB SS Structure	20	26SEP11*	01SEP11*	21OCT11	29SEP11	16	187	0.00		0.00	0.00						
1307-2260	Bid/Award CB SS Structure	30	24OCT11	30SEP11	06DEC11	10NOV11	16	187	0.00		0.00	0.00						
1307-2270	Fab & Deliver CB SS Structure	60	07DEC11	11NOV11	07MAR12	14FEB12	16	187	58,050.00		0.00	0.00						
1307-2280	30Spec/Requisition Viton O Rings	20	04SEP12*	04SEP12*	01OCT12	01OCT12	0	298	0.00		0.00	0.00						
1307-2290	Bid/Award Viton O Rings	30	02OCT12	02OCT12	12NOV12	12NOV12	0	298	0.00		0.00	0.00						
1307-2300	Fab & Deliver Viton O Rings	30	13NOV12	13NOV12	04JAN13	04JAN13	0	298	8,012.64		0.00	0.00						
1307-2310	Spec/Requisition Organ Pipe Adapters & Feedthrus	20	04SEP12*	04SEP12*	01OCT12	01OCT12	0	157	0.00		0.00	0.00						
1307-2320	Bid/Award Organ Pipe Adapters & Feedthrus	30	02OCT12	02OCT12	12NOV12	12NOV12	0	157	0.00		0.00	0.00						
1307-2330	Fab & Deliver Organ Pipe Adapters & Feedthrus	50	13NOV12	13NOV12	01FEB13	01FEB13	0	157	50,437.92		0.00	0.00						
1307-2340	Design Stud Installation Fixture	20	03OCT12*	03OCT12*	30OCT12	30OCT12	0	196	11,188.80		0.00	0.00						
1307-2350	Fabricate Fixture for Stud Installation	20	31OCT12	31OCT12	29NOV12	29NOV12	0	196	15,969.60		0.00	0.00						
1307-3010	Assemble & Test Ceramic Breaks incl PF1C Coil	20	23APR13	23APR13	20MAY13	20MAY13	0	202	31,919.20		0.00	0.00						
FY101307	FY10 Actual Cost	100	01DEC09A	01DEC09A	30APR10A	30APR10A	0		55,426.00	100	55,426.00	55,426.00						
FY101307A	FY10 Actual Cost	110	03MAY10A	03MAY10A	30SEP10A	30SEP10A	0		19,421.00	100	19,421.00	19,421.00						

1307 CS Casing Assembly (Chrzanowski)	31JAN2012	29FEB2012	31MAR2012	30APR2012	31MAY2012	30JUN2012	31JUL2012	31AUG2012	30SEP2012	31OCT2012	30NOV2012	31DEC2012
BCWS	40	40	13	0	0	9	41	43	38	61	107	111
CUM BCWS	237	277	290	290	290	299	341	384	422	483	590	700
BCWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM BCWP	140	140	140	140	140	140	140	140	140	140	140	140
ACWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM ACWP	209	209	209	209	209	209	209	209	209	209	209	209
CV	-70	-70	-70	-70	-70	-70	-70	-70	-70	-70	-70	-70
SV	-97.	-137.	-150.	-150.	-150.	-160.	-201.	-245.	-282.	-343.	-450.	-561.
CPI	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67
SPI	0.59	0.5	0.48	0.48	0.48	0.47	0.41	0.36	0.33	0.29	0.24	0.2

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

and TF bundle assembly. A single vendor will fabricate both components.
{Ohmic Heating Solenoid (Job 1305)}

WBS Element: 1.1.3.3.3

WBS Level: 5

WBS Title: Inner Poloidal Field Coils

Definition: The inner poloidal/shaping coils subsystem consists of the new coils that will make up the poloidal field coils 1A, 1B and 1C. This WBS element includes the design, analysis, prototypes (as required), procurement activities and fabrication.

For the NSTX Upgrade three new sets of inner poloidal field coils will be installed. This WBS element include the design and procurement of the Inner poloidal field coils and supports which includes all analytical and CAD design efforts for these components. It includes the early procurement of the PF conductor and co-wound [Glass/Kapton] insulation.
{Inner Poloidal Field Coils (Job 1306)}

WBS Element: 1.1.3.3.4

WBS Level: 5

WBS Title: Center Stack Casing and Assembly

Definition: This WBS element includes the design and fabrication of the Center Stack casing and ceramic break assembly for the upgraded Center Stack as well as the assembly of the new Center Stack.

The Center Stack Casing effort includes analysis and CAD design for the casing components; the procurement of the Inconel tubing, forgings, bellows and organ pipes; the fabrication of Center Stack support legs; the procurement/fabrication of a new ceramic break assembly; the in-house assembly of the casing components; and mounting of the PF1A and PF1B structure/coils to the casing.

{CS Casing (Job 1307)}

The Center Stack Assembly effort involves all activities associated with the assembly of the Center Stack and includes design modifications and upgrade of the coil assembly stand; procedures for assembling the Center Stack and for installation; assembly of the Center Stack components including the OH/TF coil supports, mounting of the surface diagnostics and thermal blanket, inconel casing and inner PF coils and setup and tear down of the Center Stack assembly area.

{Center Stack Assembly (Job 1302)}

WBS Element: 1.1.3.4

WBS Level: 4

WBS Title: Coil Bus Runs

Definition: This WBS element includes the design and fabrication of the coil bus runs/supports between the NSTX coils and the FCPC cable terminations located in the NSTX test cell.

{Coil Bus Runs (Job 5501)}

Work Approval Form (WAF)

Cost Center: 9417
Job Number: 1307
Job Title: Center Stack Vacuum Casing
Job Manager: James Chrzanowski

Description:

Includes the design and fabrication of the Centerstack casing and ceramic break assembly for the upgraded centerstack. Scope includes:

- 1) All analysis and Cad design for these components.
- 2) Procurement of the centerstack casing from OS
- 3) Includes the fabrication of CS support legs
- 4) Includes the procurement/fabrication of a new ceramic break assy
- 5) Includes the in-house assembly of the casing components.
- 6) Includes the mounting of the PF1B structure/coils to the casing


Schedule:

Refer to the Primavera Data-Base


Approvals:

 7/20/10

Job Manager

 8/3/10

Project Manager

 8/3/10

Engineering Department Head

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

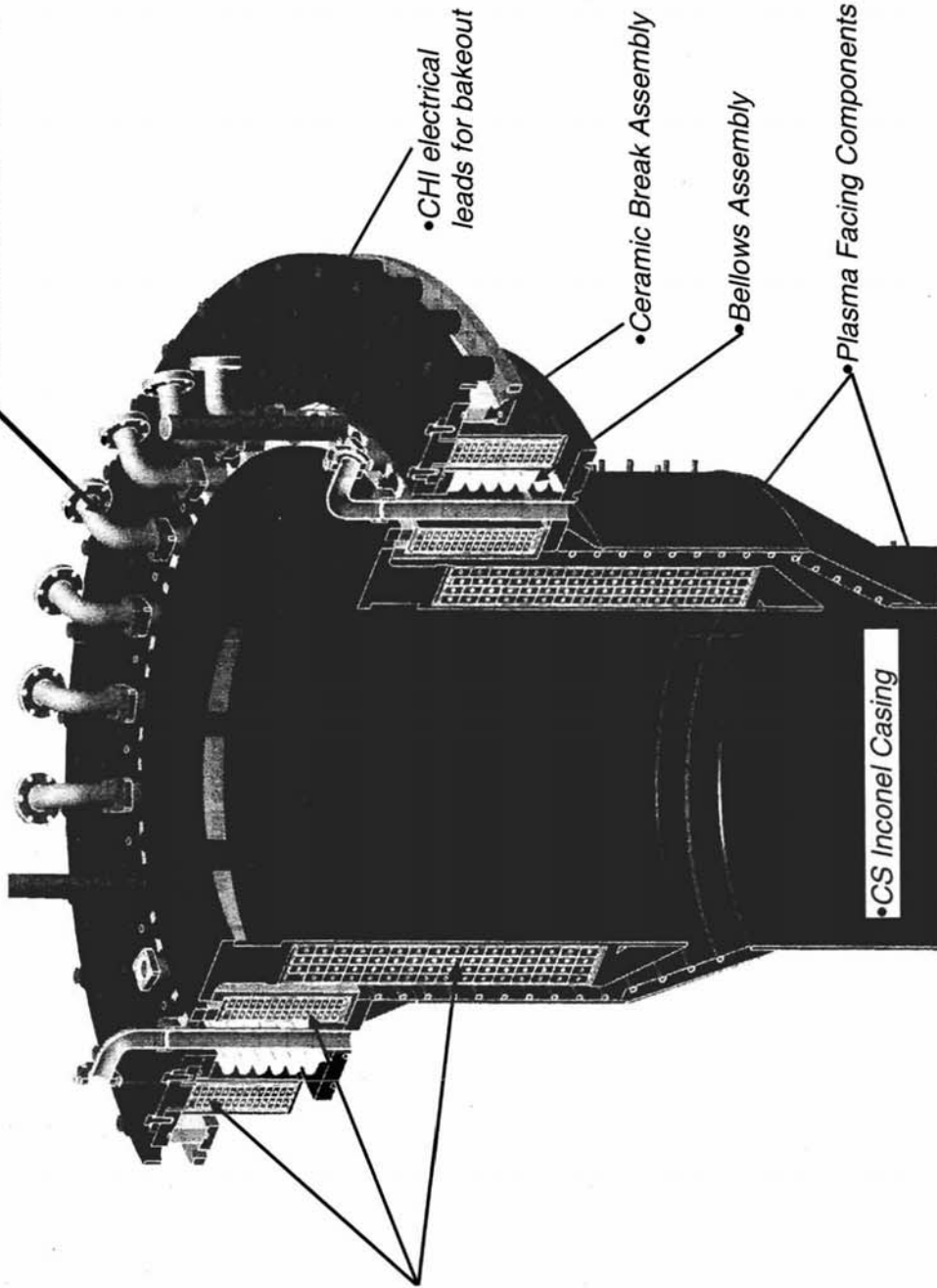
Cost Center: 9417
Job Number: 1307
Job Title: Center Stack Vacuum Casing
Job Manager: James Chrzanowski

Materials and Subcontracts (M&S)		K\$	Basis of Estimate
Description:			
CS casing manufacturing [OS]			
Inconel bellows	\$230.0	4	
Rotable flanges	\$35.0	4	
Inconel weld studs	\$17.1	4	
CS casing support structure	\$7.0	6	
Weld material	\$30.0	2	
Miscellaneous	\$5.0	2	
Bakeout leads	\$5.0	9	
Viton O-rings	\$16.0	4	
Ceramic insulators	\$5.0	4	
	\$55.0	4	
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			
TOTALS			

Rotable flanges
Inconel Forgings

Orig Costs	Inflation	New Cost
\$13.2	1.2992	\$17.1
\$30.9	1.2992	\$40.1
\$20.0	1.2992	\$26.0
	1.5	\$60.2
	3	\$78.0

• Organ pipes [diagnostics & gas]



• Inner Poloidal
Field Coils

• CHI electrical
leads for bakeout

• Ceramic Break Assembly

• Bellows Assembly

• Plasma Facing Components

• CS Inconel Casing