Work Authorization Document

NSTX Upgrade Project

Control Account #:	3400	**Title:**	Gas Delivery System Mods
WBS	1.3.4	**Title:**	Gas Delivery System
Period of Performance:	01 December 2009 through 07 November 2013		
Authorized Budget:	$102	**Control Account Manager:**	Blanchard
Revision #:	0	**Revision Date:**	July-11

Authorized Work Description:

The Gas Delivery Systems provides storage and delivery of gases to and from NSTX systems during experimental operations. These systems provide:
- Storage of on-site inventories of gases for use in NSTX plasma physics and future neutral beam experiments;
- Delivery of prescribed quantities of gases at prescribed purity levels and flow rates;
- Delivery of gases continuously or in pulses of prescribed shape and duration; and
- Evacuation of delivery lines and components required for delivery.

This WBS includes engineering design, analysis, procurement activities, component fabrication and installation to the coil, bus and component cooling manifolds at the torus.

This WBS element includes the design, fabrication and installation, and test of two center stack fueling lines and modifications of the gas delivery assemblies.

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

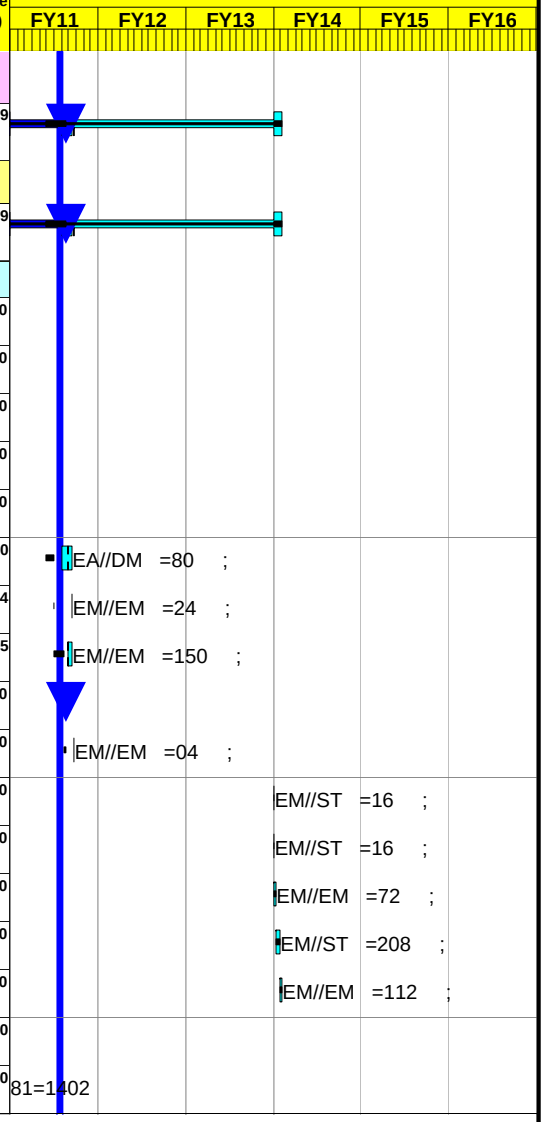
Approvals	Name	Signature	Date
NSTX-U Project Manager	R. Strykowsky		
Control Account Manager	Blanchard		
Functional Manager	L. Dudek		

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		983	01DEC09A	01DEC09A	07NOV13	07NOV13	0	205	102,288.74		2,720.00	31,694.99

Job: 3400 - Gas Delivery System Mods-BLANCHARD

Subtotal		983	01DEC09A	01DEC09A	07NOV13	07NOV13	0	205	102,288.74		2,720.00	31,694.99
3400-0016	Update Cost & Schedule Estimate - Gas Delivery S	2	03MAY10A	03MAY10A	04MAY10A	04MAY10A	0		0.00	100	0.00	0.00
3400-0017	Design Drawings - Gas Delivery Sys Mod	3	05MAY10A	05MAY10A	07MAY10A	07MAY10A	0		0.00	100	0.00	0.00
3400-0018	PDR Prep - Gas Delivery Sys Mod	9	10JUN10A	10JUN10A	22JUN10A	22JUN10A	0		0.00	100	0.00	0.00
3400-0019	CONDUCT PDR - Gas Delivery Sys Mod	1	23JUN10A	23JUN10A	23JUN10A	23JUN10A	0		0.00	100	0.00	0.00
3400-0022	Disposition PDR Chits - Gas Delivery Sys Mod	2	23JUN10A	23JUN10A	24JUN10A	24JUN10A	0		0.00	100	0.00	0.00
3400-0023	Design Drawings - Gas Delivery Sys Mod	34	01MAR11*	02MAY11*	28MAR11	17JUN11	-58	123	10,148.00		0.00	10,148.00
3400-0025	Update Cost & Schedule Estimate - Gas Delivery S	5	29MAR11	13JUN11	04APR11	17JUN11	-53	123	3,797.04		0.00	3,797.04
3400-0027	FDR Prep - Gas Delivery Sys Mod	15	05APR11	27MAY11	16MAY11	17JUN11	-23	123	23,731.50		0.00	15,029.95
3400-0027A	Gas Delivery System - Peer review	0				18MAY11*	0	147	0.00		0.00	0.00
3400-0028	CONDUCT FDR	3	17MAY11*	22JUN11*	17MAY11	24JUN11	-27	121	632.84		0.00	0.00
3400-0046	Shop Fabrication - Gas Delivery Sys Mod	1	01OCT13*	01OCT13*	01OCT13	01OCT13	0	205	1,837.44		0.00	0.00
3400-0047	Assembly - Gas Delivery Sys Mod	1	02OCT13	02OCT13	02OCT13	02OCT13	0	205	1,837.44		0.00	0.00
3400-0050	Installation Procedure/Oversight - Gas Delivery	6	03OCT13	03OCT13	10OCT13	10OCT13	0	205	13,186.08		0.00	0.00
3400-0051	Machine Installation - Gas Delivery Sys Mod	13	11OCT13	11OCT13	29OCT13	29OCT13	0	205	23,886.72		0.00	0.00
3400-0052	PTP Testing/Programming - Gas Delivery Sys Mod	7	30OCT13	30OCT13	07NOV13	07NOV13	0	205	20,511.68		0.00	0.00
FY103400	FY10 Actual Cost	17	01DEC09A	01DEC09A	23DEC09A	23DEC09A	0		1,318.00	100	1,318.00	1,318.00
FY103400A	FY10 Actual Cost	130	01APR10A	01APR10A	30SEP10A	30SEP10A	0		1,402.00	100	1,402.00	1,402.00



Data Date 30APR11
Run Date 20MAY11 11:00

1105

NSTX UPGRADES
RESOURCE LOADED SCHEDULE
CD-2 Schedule
April 2011

Early Bar
Progress Bar
Critical Activity

3400 Gas Delivery System Mods (Blanchard)	START	28FEB2009	31MAR2009	30APR2009	31MAY2009	30JUN2009	31JUL2009	31AUG2009	30SEP2009	31OCT2009	30NOV2009	31DEC2009
BCWS	0	0	0	0	0	0	0	0	0	0	0	1
CUM BCWS	0	0	0	0	0	0	0	0	0	0	0	1
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.
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

3400 Gas Delivery System Mods (Blanchard)	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	1	1	1	2	2	2	2	2	3	3	3	3
BCWP	0	0	0	0	0	0	0	0	0	0	0	3
CUM BCWP	0	0	0	0	0	0	0	0	0	0	0	3
ACWP	0	0	0	0	0	0	0	0	0	0	0	3
CUM ACWP	0	0	0	0	0	0	0	0	0	0	0	3
CV	0	0	0	0	0	0	0	0	0	0	0	0
SV	-1.	-1.	-1.	-2.	-2.	-2.	-2.	-2.	-3.	-3.	-3.	.
CPI	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.
SPI	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1

3400 Gas Delivery System Mods (Blanchard)	31JAN2011	28FEB2011	31MAR2011	30APR2011	31MAY2011	30JUN2011	31JUL2011	31AUG2011	30SEP2011	31OCT2011	30NOV2011	31DEC2011
BCWS	0	0	12	17	9	0	0	0	0	0	0	0
CUM BCWS	3	3	15	32	41	41	41	41	41	41	41	41
BCWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM BCWP	3	3	3	3	3	3	3	3	3	3	3	3
ACWP	0	0	1	0	0	0	0	0	0	0	0	0
CUM ACWP	3	3	3	3	3	3	3	3	3	3	3	3
CV	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
SV	.	.	-12.	-29.	-38.	-38.	-38.	-38.	-38.	-38.	-38.	-38.
CPI	1.	1.	.79	.79	.79	.79	.79	.79	.79	.79	.79	.79
SPI	1	1	0.18	0.09	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07

3400 Gas Delivery System Mods (Blanchard)	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	41	41	41	41	41	41	41	41	41	41	41	41
BCWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM BCWP	3	3	3	3	3	3	3	3	3	3	3	3
ACWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM ACWP	3	3	3	3	3	3	3	3	3	3	3	3
CV	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
SV	-38.	-38.	-38.	-38.	-38.	-38.	-38.	-38.	-38.	-38.	-38.	-38.
CPI	.79	.79	.79	.79	.79	.79	.79	.79	.79	.79	.79	.79
SPI	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07

3400 Gas Delivery System Mods (Blanchard)	31JAN2013	28FEB2013	31MAR2013	30APR2013	31MAY2013	30JUN2013	31JUL2013	31AUG2013	30SEP2013	31OCT2013	30NOV2013	31DEC2013
BCWS	0	0	0	0	0	0	0	0	0	47	15	0
CUM BCWS	41	41	41	41	41	41	41	41	41	88	102	102
BCWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM BCWP	3	3	3	3	3	3	3	3	3	3	3	3
ACWP	0	0	0	0	0	0	0	0	0	0	0	0
CUM ACWP	3	3	3	3	3	3	3	3	3	3	3	3
CV	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
SV	-38.	-38.	-38.	-38.	-38.	-38.	-38.	-38.	-38.	-85.	-100.	-100.
CPI	.79	.79	.79	.79	.79	.79	.79	.79	.79	.79	.79	.79
SPI	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.03	0.03	0.03

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

This WBS element includes the purchase of a new more powerful power supply, to replace the existing one, to be used for electrical heating of the vessel. It is proposed to buy a 0-8V, 8000 amps for the application. Suitable cable leads will be fabricated and necessary interlocks will be incorporated.
{NSTX CSU Bakeout System Mods (Job 3300)}

WBS Element: 1.3.4 **WBS Level: 3**
WBS Title: Gas Delivery Systems
Definition: The Gas Delivery Systems provides storage and delivery of gases to and from NSTX systems during experimental operations. These systems provide:

- Storage of on-site inventories of gases for use in NSTX plasma physics and future neutral beam experiments;
- Delivery of prescribed quantities of gases at prescribed purity levels and flow rates;
- Delivery of gases continuously or in pulses of prescribed shape and duration; and
- Evacuation of delivery lines and components required for delivery.

This WBS includes engineering design, analysis, procurement activities, component fabrication and installation to the coil, bus and component cooling manifolds at the torus.

This WBS element includes the design, fabrication and installation, and test of two center stack fueling lines and modifications of the gas delivery assemblies.
{Gas delivery system modifications (Job 3400)}

WBS Element: 1.3.5 **WBS Level: 3**
WBS Title: Glow Discharge Cleaning System
Definition: The Glow Discharge Cleaning (GDC) System establishes and controls the GDC process in NSTX. GDC is a mode of vacuum conditioning in which the vacuum vessel internal surfaces are cleaned by the bombardment of ions formed during the glow process. This WBS includes engineering design, analysis, procurement activities, component fabrication and installation of the GDC system. There are no changes to the Glow Discharge Cleaning system as part of the NSTX Upgrade Project.

WBS Element: 1.4 **WBS Level: 2**
WBS Title: Plasma Diagnostics
Definition: The Plasma Diagnostics provide information on discharge parameters to characterize NSTX plasmas and guide its operation for optimized performance. The near term emphasis will be on detailed measurements of plasma profiles, using equipment presently available at PPPL. The long term objective will be to provide input for advanced plasma control systems, using new concepts and systems developed by the national NSTX team.

Work Approval Form (WAF)

Cost Center: 9417
Job Number: 3400
Job Title: Gas Delivery System Mods for CSU
Job Manager: W. Blanchard
Rev 1 6/2/2010

Description:

Design, fabricate, install and test four center stack fueling lines and modify gas delivery assemblies.

Schedule:

See Tab B or attached

Approvals:

W. Blanchard 7.21.10
Job Manager

8/3/10
Project Manager

8/3/10
Engineering Department Head

Cost Center:	**9417**	
Job Number:	**3400**	
9417	**Gas Delivery System Mods for CSU**	
Job Manager:	**W. Blanchard**	

Rev 1 6/2/

USER INPUT TASKS AND DESCRIPTIONS

task numb	P3 cross ref (optinal)	TASK DESCRIPTION	Responsible	SCHEDULE *USER INPUT* DURATION in WORK DAYS	*Logical Pre-requisites (one task numbers in each column ,any order)*	User Input Start Date (optional)	Calculated START DATE	Calculated FINISH DATE
1		**Physics Requirements**						
2								
3		**Conceptual Design**						
4		PREPARE WORK PLANNING FORM	Atnafu/Blanchard					
5		Prep System Description	Atnafu/Blanchard					
6		Prep System Requirements	Atnafu/Blanchard					
7		R&D						
8		Analysis						
9		CDR	Atnafu/Blanchard					
10								
11		**Preliminary Design**						
12		Thermal Analysis						
13		Seismic Analysis						
14		FMEA Analysis						
15		Prepare NEPA Form						
16		Update Cost & Schedule Estimate	Atnafu/Blanchard					
17		Design Drawings	Drafting					
18		PDR Prep	Atnafu/Blanchard					
19		CONDUCT PDR	Atnafu/Blanchard					
20								
21		**Final Design**						
22		Disposition PDR Chits	Atnafu/Blanchard					
23		Design Drawings	Drafting					
24		Update Analyses						
25		Update Cost & Schedule Estimate	Atnafu/Blanchard					
26		Prep Procurement Specs						
27		FDR Prep	Atnafu/Blanchard					
28		CONDUCT FDR	Atnafu/Blanchard					
29								
43								
44		**Fab/Assembly**						
45		Fab/Assy Procedure						
46		Shop Fabrication	Tech					
47		Assembly	Tech					
48								
49		**Installation**						
50		Installation Procedure/Oversight	Atnafu/Blanchard					
51		Machine Installation	Tech					
52		PTP Testing/Programming	Atnafu/Blanchard					
53								
54		OTHER TASKS						
55								
		TOTALS						
		TOTAL Preliminary Cost Estimate ($k)=		$131				

Estimate (user input)

actual= A	FY10$K M&S (41)	FY10$K CREDIT CARD (43)	FY10$K OTHER (39)	HOURS (priced at FY10 rates) EA** EM (analysis engr)	EA** EM (Designer)	EC** TB (Computing Tech)	EE** EM (Elct Engr)	EE** SM (Senior Electr Tech)	EE** SB (Elect Tech)	EE** TB (Electr Tech)	EM** EM (FO&M Engr)	EM** SM Senior Tech)	EM** SB (FO&M Tech)	EM** TB (FO&M Tech)	DP** SB/TB (HP Tech)	EC** AM (P&C Officer)	% CONTIGNECY %	Names of req'd skills if known	Basis of Estimate Category
											12						15%		2
											24						15%		2
											24						15%		2
											48						15%		2
											24						15%		2
					48												15%		2
											108						15%		2
											4						15%		2
											24						15%		2
					80												15%		2
											24						15%		2
											150						15%		2
											4						15%		2
														16			25%		2
														16			25%		2
											72						25%		2
														208			25%		2
											112						25%		2
				$0	$0	$0	128	-	-	-	-	-	630	-	-	240	-	-		
				$0	$0	$0	$0	$15	$0	$0	$0	$0	$0	$94	$0	$0	$21	$0	$0		

Job Number:	**3400**
9417	**Gas Delivery System Mods for CSU**
Job Manager:	**W. Blanchard**

Rev 1 6/2/ — ***USER INPUT TASKS AND DESCRIPTIONS***

task	TASK DESCRIPTION	Responsible	SCHEDULE: DURATION in WORK DAYS	SCHEDULE: *Logical Pre-requisites (one task numbers in each column ,any order)*	SCHEDULE: User Input Start Date (optional)	SCHEDULE: Calculated START DATE	SCHEDULE: Calculated FINISH DATE	actual= A	FY10$K: M&S (41)	FY10$K: CREDIT CARD (43)	FY10$K: OTHER (39)	HOURS (priced at FY10 rates): EA** EM (analysis engr)	HOURS: EA** (Designer)	HOURS: EC** TB (Computing Tech)	HOURS: EE** EM (Elct Engr)	HOURS: EE** SM (Senior Electr Tech)	HOURS: EE** SB (Electr Tech)	HOURS: EE** TB (Electr Tech)	HOURS: EM** EM (FO&M Engr)	HOURS: EM** SM Senior Tech)	HOURS: EM** SB (FO&M Tech)	HOURS: EM** TB (FO&M Tech)	HOURS: DP** SB/TB (HP Tech)	HOURS: FC** AM (P&C Officer)	% CONTINGENCY %	Names of req'd skills if known	Basis of Estimate Category
	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																			

Estimate (user input)

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 - Catelogue Price/Vendor Quote ____
7 - Placed Contracts ____
8 - Actual experience for NCSX Work ____
9 - Other

Cost Center:	9417															
Job Number:	3400															
## 9417	Gas Delivery System Mods for CSU															
Job Manager:	W. Blanchard															
Rev 1 6/2/2010																
		High	**Medium**	**Low**	**Uncertainty Range (%)**	**Comments/Other Considerations**										
	Design Maturity			**X**	**20**											
	Design Complexity			**x**	**20**											

Residual Impacts

	Risk Description	Likelihood of Occurring	Mitigation Plan	Basis of estimate	Cost Impact		Schedule Impact	
					Low ($K)	High ($K)	Low (weeks)	High (Weeks)
1	Fueling lines do not adequately deliver gas because of the occlusions or leaks	near zero	Replace gas delivery line	Similar project was completed on existing machine				
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 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: 3400
9417 9417 Gas Delivery System Mods for CSU
Job Manager: W. Blanchard

Rev 1 6/2/2010

Materials and Subcontracts (M&S)

Description: Gas delivery lines and fittings	$2,500.00	Basis of Estimate: Previous installation on NSTX

CATEGORIZATION CODES:				
1 - National Standards	1	$	-	0%
2 - Engineering Judgement/Experience	2	$	-	0%
3 - Estimates/Data from External Sources (e.g., W7X, ATF, etc.)	3	$	-	0%
4 - Previous PPPL/ORNL Experieince (e.g., TFTR, NSTX, PLT, etc.)	4	$	1,000	100%
5 - Prototype Data/Test Results	5	$	-	0%
6 - Catelogue Price/Vendor Quote	6	$	-	0%
7 - Placed Contracts	7	$	-	0%
8 - Actual experience for NCSX Work	8	$	-	0%
9 - Other	9	$	-	0%
TOTALS		$	1,000	100%