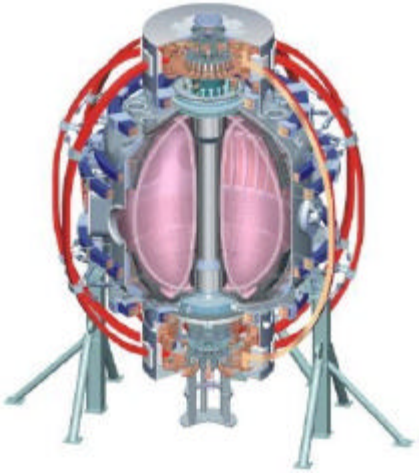
Cost and Schedule

College W&M
Colorado Sch Mines
Columbia U
CompX
General Atomics
INEL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
New York U
Old Dominion U
ORNL
PPPL
PSI
Princeton U
Purdue U
SNL
Think Tank, Inc.
UC Davis
UC Irvine
UCLA
UCSD
U Colorado
U Illinois
U Maryland
U Rochester
U Washington
U Wisconsin

Ron Strykowsky

Princeton Plasma Physics Laboratory

NSTX Upgrade Project
Office of Science Review
LSB, B318
December 15-16, 2009



Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAEA
Hebrew U
Ioffe Inst
RRC Kurchatov Inst
TRINITI
KBSI
KAIST
POSTECH
ASIPP
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

Topics

- **Basis of Estimate**
- **Results**

  (Cost, funding requirements, schedule, staffing)
- **Plans forward**
- **Conclusion**

  (Address charge questions)

Estimate Formulation based on a disciplined process

- Job Managers Prepared Work Authorization Forms (WAF's) - realistic "center-of-errors bars" estimate

  Disciplined and uniform approach for all work

  Excel based spreadsheet includes;

  Tab A – Work scope description

  Tab B – Detail estimate; Tasks, resource estimates (labor hours by skill and material cost), schedule and task durations, basis of estimates

  Tab C – Estimate uncertainty and Risk

  Estimate Uncertainty – Design maturity and complexity

  Risk – Likelihood, cost and schedule impact

  Tab D – Materials, hardware detail and other backup estimate basis
- Internal Engineering Department Review for all Job Estimates
- Prepared resource Loaded Schedule (Primavera)

  1457 tasks, 1751 links, 2259 individual resource loadings
- Quantified Contingency by considering the estimate uncertainty (design complexity and design maturity) and Risk

•The WAF's are the basis of all estimates
•Risks were entered into the project risk registry and used to quantify contingency
•Estimate uncertainty was used to quantify contingency
•The resource loaded schedule is the master schedule and cost estimate data base

WAF's are the vehicle for estimating cost, schedule and risk

Work Approval Form (WAF)

Cost Center: 1170
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 performa 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 configur 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:

____
Job Manager

____
Project Manager

____
Engineering Department Head

Cost Center: 1170
Job Number: 1303
Job Title: TF Joint Test Stand & Performance Test
Job Manager: Tom Kozub

Estimate (user input)

task	USER INPUT TASKS AND DESCRIPTIONS: TASK DESCRIPTION	Responsible	SCHEDULE USER INPUT: DURATION in WORK DAYS	OPTIONAL Logical Pre-requisites (one task numbers in each column ,any order)				FY09$K: M&S (41)	CREDIT CARD (43)	OTHER (39)	TRAVEL (35)	OVERTIME (31)	HOURS: EA** EM (analysis engr)	EA** DM (Designer)	EC** EM (computing Engr)	EC** SM/TB (Computing Tech)	EE** EM (Elctr Engr)	EE** SM/TB (Electr Tech)	EM** EM (FO&M Engr)	EM** SM/TB (FO&M Tech)	FC** AM (P&C Officer)	DP** SB/TB (HP Tech)	Basis of Estimate and Names of req'd skills if known	Category
								$1	$1,000	$1,716	$1,716	$1,716	168.7	168.7	156.5	128.6	108.4	78.33	180.79					
10																								
11	**Preliminary Design**																							
15	Prepare NEPA Form		5	9															16				Prior NSTX Center Stack Testing - Test Engineer	2,4
16	Update Cost & Schedule Estimate		5	9															8				Prior NSTX Center Stack Testing - Test Engineer	2,4
17	Design Drawings		20	9										40					40				Prior NSTX Center Stack Testing - Test Engineer & Designer Draftsman	2,4
18	PDR Prep		10	9															40				Prior NSTX Center Stack Testing - Test Engineer	2,4
19	CONDUCT PDR		5	15	16	17	18												8				Prior NSTX Center Stack Testing - Test Engineer	2,4
20																								
21	**Final Design**																							
22	Disposition PDR Chits		5	19															24				Prior NSTX Center Stack Testing - Test Engineer	2,4
23	Design Drawings		20	22										80					16				Prior NSTX Center Stack Testing - Test Engineer &	2,4
24	Update Analyses																							
25	Update Cost & Schedule Estimate		2	22															8				Prior NSTX Center Stack Testing - Test Engineer	2,4
26	Prep Procurement Specs		3	22															16				Prior NSTX Center Stack Testing - Test Engineer	2,4
27	FDR Prep		10	22															40				Prior NSTX Center Stack Testing - Test Engineer	2,4
28	CONDUCT FDR		1	24	25	26	27												8				Prior NSTX Center Stack Testing - Test Engineer	2,4

CATEGORIZATION CODES:

1 - National Standards
2 - Engineering Judgement/Experience
3 - Estimates/Data from External Sources (e.g., W7X, ATF, etc.)
4 - Previous PPPL/ORNL 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

Cost Center: 1170
Job Number: 1303
Job Title: TF Joint Test Stand & Performance Test
Job Manager: Tom Kozub

Uncertainty of the Estimate

	High	Medium	Low	Uncertainty Range (%)	Comments/Other Considerations
Design Maturity		X		20	Similar tests have been performed before successfully. The designs will be new and different although similar. It is expected that as the design is analyzed and tested that it will change and this will be an iterative development with several design, fabricate and test cycles.
Design Complexity		X		20	Similar tests have been performed before successfully. The designs will be new and different although similar.

Residual Impacts

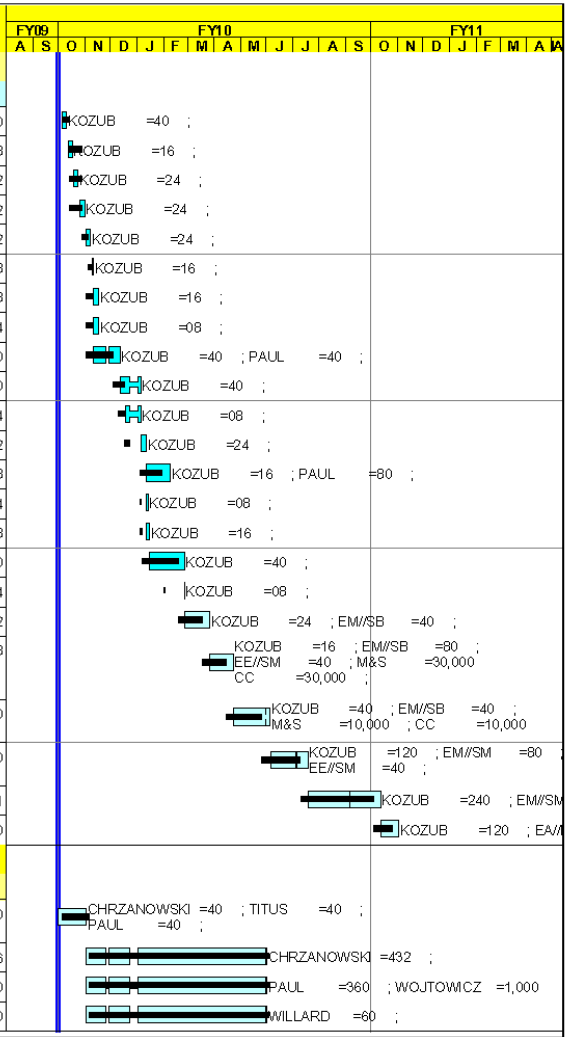
	Risk Description	Likelihood of Occurring	Mitigation Plan	Basis of estimate	Cost Impact Low ($K)	Cost Impact High ($K)	Schedule Impact Low (weeks)	Schedule Impact High (Weeks)
1	Significant change in TF design concept	U	Perform additional work	Past testing jobs	10	50	2	10
2	Increased number of redesign/retest cycles	U	Perform additional work	Past testing jobs	10	50	2	10
3	Unexpected technical challenges in implementing testing apparatus and procedures	U	Perform additional work	Past testing jobs	0	30	2	4

Design Complexity (columns) / **Design Maturity** (rows)

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%

The resource loaded schedule is the master database for all cost, schedule, and resource requirements

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish	Total Float	Budgeted Cost
Job: 1303 - TF Joint Test Stand&Test-CHRZANOWSKI						
CS13030010	Physics Requirements	5	05OCT09*	09OCT09	517	6,595.20
CS13030020	PREPARE WORK PLANNING FORM	5	12OCT09	16OCT09	517	2,638.08
CS13030030	Prep System Description	5	19OCT09	23OCT09	517	3,957.12
CS13030040	Prep System Requirements	5	26OCT09	30OCT09	517	3,957.12
CS13030050	R&D	5	02NOV09	06NOV09	517	3,957.12
CS13030060	CDR	2	09NOV09	10NOV09	517	2,638.08
CS13030070	Prepare NEPA Form	5	11NOV09*	17NOV09	517	2,638.08
CS13030080	Update Cost & Schedule Estimate	5	11NOV09	17NOV09	537	1,319.04
CS13030090	Design Drawings	20	11NOV09	10DEC09	517	11,728.80
CS13030100	PDR Prep	10	11DEC09	04JAN10	517	6,595.20
CS13030110	CONDUCT PDR	5	18DEC09	04JAN10	517	1,319.04
CS13030120	Disposition PDR Chits	5	05JAN10	11JAN10	517	3,957.12
CS13030130	Design Drawings	20	12JAN10	08FEB10	529	12,905.28
CS13030140	Update Cost & Schedule Estimate	2	12JAN10	13JAN10	547	1,319.04
CS13030150	Prep Procurement Specs	3	12JAN10	14JAN10	517	2,638.08
CS13030160	FDR Prep	30	15JAN10	25FEB10	517	6,595.20
CS13030170	CONDUCT FDR	1	25FEB10	25FEB10	517	1,319.04
CS13030180	Fab/Assy Procedure	20	26FEB10	25MAR10	517	8,874.32
CS13030190	Shop Fabrication	20	26MAR10	22APR10	517	91,562.48
CS13030200	Assembly	30	23APR10*	04JUN10	517	35,712.40
CS13030210	Machine Installation	30	07JUN10	19JUL10	517	38,663.60
CS13030220	PTP Testing	60	20JUL10	12OCT10	517	64,448.11
CS13030230	Final Report & Presentation	15	13OCT10	02NOV10	517	24,599.60
Job: 1304 - Inner TF Bundle (Ds/Fab)-CHRZANOWSKI						
Design						
CS13040010	CDR	23	01OCT09*	02NOV09	313	20,636.00
CS13040020	Preliminary design of TF bundle and components	141	03NOV09	01JUN10	425	83,712.96
CS13040030	Gen Detl/assembly Cad drwngs [TF bundle, joint	141	03NOV09	01JUN10	425	131,864.80
CS13040040	Analysis of Revised Flag/Flex Geometry	141	03NOV09	01JUN10	425	9,892.80



Data Date 01OCT09
Run Date 19NOV09 15:49

Early Bar
target cs10
Progress Bar
Critical Activity

CD1C

NSTX UPGRADES
RESOURCE LOADED SCHEDULE
Conceptual Design (CD-1)
CONSTRAINED CASE

Sheet 1A of 3B

Project Scope (WBS) provides basis for estimating and managing

Project WBS

WBS	WAF (Detail of Estimate)	Responsible Job Manager
1.1 Torus Systems		
	1000 CSU Analytical Support	Pete Titus
1.1.1 Plasma Facing Components		
	1001 CS- PLASMA FACING COMPONENTS	Kelsey Tresemer
	1002 Passive Plate Analysis and Upgrade Activities	Pete Titus
1.1.2 Vacuum Vessel & Support Structure		
	120x CSU STRUCTURAL SUPPORTS	Danny Mangra
1.1.3 Magnet Systems		
	1300 CENTER STACK DESIGN SUPPORT	Jim Chrzanowski
1.1.3.1 Outer Polidal Field Coils		
1.1.3.2 Outer Toroidal Field Coils		
	1301 Outer TF Coil Repairs	Jim Chrzanowski
1.1.3.3 Center Stack		
	1302 CENTER STACK ASSEMBLY	Jim Chrzanowski
1.1.3.3.1 TF Inner legs		
	1303 TF Joint Test Stand & Performance of Test	Tom Kozub
	1304 INNER TF BUNDLE- Design & Fabrication	Jim Chrzanowski
1.1.3.3.2 Ohmic Heating Solenoid		
	1305 OHMIC HEATING COIL (OH)	Jim Chrzanowski
1.1.3.3.3 Shaping Coils		
	1306 Inner POLOIDAL FIELD COILS (IPF)	Jim Chrzanowski
1.1.3.3.4 Center Stack Casing		
	1307 CS CASING Assembly- Design & Fabrication	Jim Chrzanowski
1.2 Plasma Heating and Current Drive Systems		
1.2.1 High Harmonic Fast Wave		
1.2.2 Coaxial Helicity Injection Current Drive		
1.2.3 Electron Cyclotron Heating		
	2300 ECH	Pete Titus
1.2.4 Neutral Beam Injection		
	2420 NBI - Sources	Mark Cropper
	2425 NBI - Beamline Relocation	Martin Denault
	2430 NBI - Decontamination	Tim Stevenson
	2440 NBI - Beamline Refurbishment	Martin Denault
	2450 NBI - Services	Martin Denault
	2460 NBI - Armor/Protective Plates	Craig Priniski
	2470 NBI - Power	Raki Ramakrishnan
	2475 NBI - Controls	Mark Cropper
	2480 NBI - Nozzle/Duct	Craig Priniski
	2490 NBI - Equipment Relocations	Erik Perry

WBS	WAF (Detail of Estimate)	Responsible Job Manager
1.3 Auxiliary Systems		
1.3.1 Vacuum Pumping Systems		
	2485 Vacuum Pumping Systems	Craig Priniski
1.3.2 Coolant Systems		
	3200 Water Cooling System Mods for CSU	Martin Denault
1.3.3 Bakeout System		
	3300 Bakeout System mods for CSU	Raki Ramakrishnan
1.3.4 Gas Delivery Systems		
	3400 Gas Delivery System Mods for CSU	Bill Blanchard
1.3.5 Glow Discharge Cleaning System		
1.4 Plasma Diagnostics		
	4100 Center Stack Diagnostics for CSU	Bob Kaita
1.5 Power Systems		
	5000 CS Power Systems	Raki Ramakrishnan
	5501 COIL BUS RUNS	Jim Chrzanowski
1.6 Central Instrumentation & Control		
	6100 Control System & Data Acquisition System	Paul Sichta
1.7 Project Support & Integration		
	7100 Project Management & Integration	Ron Strykowsky
	7200 Center Stack Management	Larry Dudek
	7300 NB2 Management	Tim Stevenson
	7400 Health Physics Support	Tim Stevenson
	7700 Direct Allocations	Ron Strykowsky
	7710 Upgrade Allocations	Ron Strykowsky
	7900 Integrated Systems Test	Charlie Gentile
1.8 Site Preparation and Torus Assembly		
	8200 Centerstack and Coil structure Installation	Mike Viola
	8250 Centerstack removal & re-installation	Mike Viola

Key Planning Basis and Assumptions

- TPC - from January 1st, 2009
- Institutional Overhead and Labor Rates
- Standard work week 8hrs/day 5 days/ week
- No overtime or Saturday work planned. Overtime and Saturday used to maintain schedule.
- Holidays included
- Task durations based on deliverables and/or tasks identified by the job managers
- Established tasks, internal milestones (PDR's, FDR's, contract awards)
- Task durations based on realistic resource loadings & crew sizes

Risk Registry used to tabulate and manage project risk

NSTX Upgrade Project Risk Registry, rev 8

Number	Affected Job	Job Title	Risk Description	Mitigation Plan (& job where budgeted)	Deadline to Retire Risk or Absorb Impact	Owner	Current Status	Likelihood of Occurrence	Basis of Estimate	Cost Impact ($K)	Critical Path Schedule Impact (weeks)	Cost and Schedule Impact Calculation Basis	Project Manager Assessment: Cost Impact used for contingency calc	Project Manager Assessment: justification
1303c	1303		Unexpected technical challenges in implementing testing apparatus and procedures	Perform additional work	PDR	Kozub	open	VU	manager's estimate	0 to 30		past experience	15	average cost impact used
1305a	1305	OH Coil Design and Fabrication	No vendor bids for OH/TF fabrication	Fabricate coil in-house [Suggest having bid process include both domestic and international]	OH coil fabrication	Chrzanowski	Retired - Now in job	U						
1305b	1305		VPI - poor impregnation	Evaluate condition of coil - Local dry areas could be repaired, but larger failure would require cutting OH coil from TF and rebuild OH	OH coil fabrication	Chrzanowski	open	U	manager's estimate	500	0	repeat fabrication tasks	0	2 failures on 1 coil extremely unlikely
1305c	1305		OH coil fails during final testing	If fault cannot be repaired, coil must be cut off and rebuilt	OH coil fabrication	Chrzanowski	open	U	manager's estimate	550	0	cost to cut off coil and repeat fabrication tasks	550	
1306a	1306	Inner PF Coils Design and Fabrication	Poor impregnation	Local dry areas can be repaired. Extensive areas of poor VPI may require rewinding new coil.	PF coil fabrication	Chrzanowski	open	U	manager's estimate	50 to 200	0	repeat fabrication tasks	125	average cost impact used
	2425	NB2 Relocation	None											
	2430	NB2 Decontamination	None											
2440b	2440		Existing copper parts may be reusable (except for the dump)	Negative risk - reduce scope of job	PDR	Denault	open	L	project manager's estimate	-234			-234	

Contingency Methodology Recognizes Uncertainty & Risk

- **Lower Range**
  - •Average range of estimate uncertainty (1) (%) x base estimate ($)
  - +
  - •Risk Cost ($) x likelihood *(weighted) (%)*
  - +
  - •Schedule contingency (critical path tasks average uncertainty (%) x total schedule length (mos.) x standing army cost ($/mo.)
- **Upper Range**
  - •High estimate uncertainty (1) (%) x base estimate ($)
  - +
  - •Risk Cost ($) *(not weighted)*
  - +
  - •Schedule contingency (critical path tasks average uncertainty (%) x total schedule length (mos.) x standing army cost ($/mo.)

•Contingency distribution by FY based upon uncertainty and risk retirement dates

(1) Estimate uncertainty consistent with AACE cost estimate classification system

Summary Cost Profile

TPC ($K)

Unconstrained Case	FY2009	FY2010	FY2011	FY2012 (No Operations)	FY2013 (No Operations)	FY2014	FY2015	TOTAL
Base Estimate	$5,146	$11,469	$12,731	$28,894	$11,765	$249		$70,254
Lower Contingency		$358	$694	$2,436	$1,344	$1,762		$6,593
Total Lower Bound	**$5,146**	**$11,827**	**$13,425**	**$31,330**	**$13,109**	**$2,010**		**$76,848**
Upper Contingency		$1,507	$2,956	$11,020	$6,059	$1,817		$23,359
Total Upper Bound	**$5,146**	**$12,977**	**$15,687**	**$39,914**	**$17,824**	**$2,066**		**$93,613**
Anticipated Guidance	*$5,146*	*$8,000*	*$7,340*	*$26,839*	*$28,129*	*$9,215*		*$84,669*

Constrained Case	FY2009	FY2010	FY2011	FY2012	FY2013 (No Operations)	FY2014 (No Operations)	FY2015	TOTAL
Base Estimate	$5,146	$10,693	$7,654	$9,418	$27,423	$13,468	$18	$73,820
Lower Contingency		$345	$310	$705	$2,170	$1,494	$1,757	$6,781
Total Lower Bound	**$5,146**	**$11,038**	**$7,964**	**$10,123**	**$29,593**	**$14,962**	**$1,775**	**$80,601**
Upper Contingency		$1,449	$1,314	$3,095	$9,843	$6,794	$1,810	$24,304
Total Upper Bound	**$5,146**	**$12,142**	**$8,968**	**$12,513**	**$37,265**	**$20,262**	**$1,828**	**$98,124**
Anticipated Guidance	*$5,146*	*$8,000*	*$7,340*	*$10,750*	*$28,130*	*$28,500*	*$6,260*	*$94,126*

Funding Sources

	FY09 Actual	FY10	FY11	FY12	FY13	FY14	FY15	
Incremental program funding			$1.2	$5.6	$7.5	$8.5	$6.8	$29.6
Savings from operations (ops divetred to UG)					$15.9	$15.8		$31.7
Upgrade monies built into base that are being applied to the UG	$5.2	$5.2	$5.2	$5.2	$5.2	$5.2	$5.2	$36.4
	$5.2	$5.2	$6.4	$10.8	$28.6	$29.5	$12.0	$97.7

Net new incremental funding required = $12.5 to $30.0

NSTX Upgrade Cost & Schedule Issue

- The constrained funding scenario is predicated on *preliminary* out year guidance from DOE

- There is still a short fall in FY 2010 which is being actively addressed by DOE and PPPL
  - Opportunity
    - Additional funds in FY 2010 (as communicated) will position the project to support a 4 year plan should additional funding become available in FY2011/2012 and/or further cost reductions can be realized during the preliminary design chase.
  - Risk
    - The FY 2010 funding currently available if left to stand would necessitate a further delay, with cost escalation, to the project and NSTX research program.

Cost and Schedule Opportunities

The project is currently pursuing potential reductions to the base estimate.

1) Simplification and optimization of the coil support structures.

The addition of the Machine Protection System (MPS) would control and limit power to the coils which may negate the need for a robust PF support structure. Savings would result from reduced material cost AND significantly less ancillary hardware removals and re-installations.

2) Hardware Installation.

Further review of the assembly plan reveals potential optimization of steps required and labor reductions.

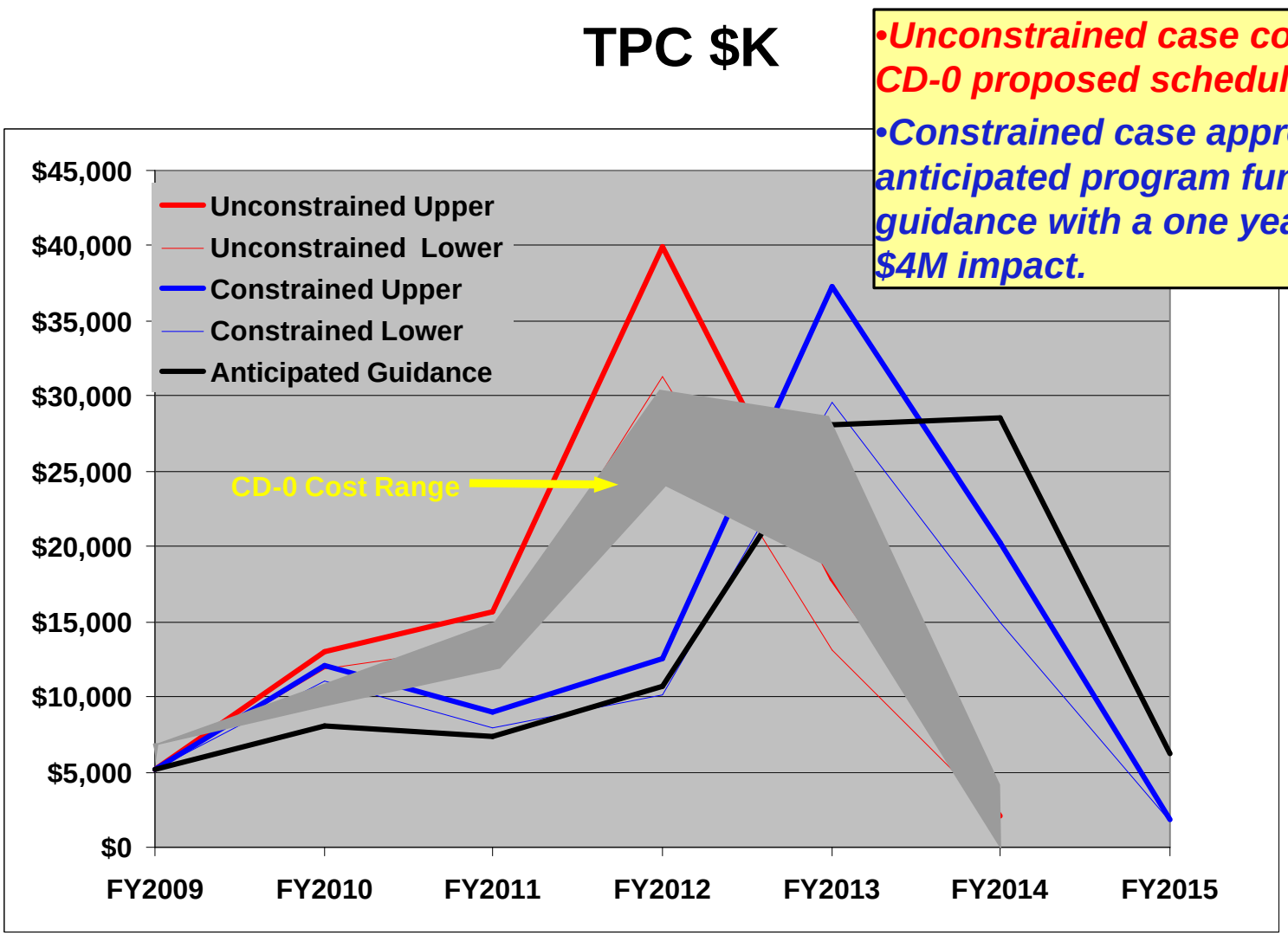
3) Conservative base estimates.

Cost Estimate Detail (TPC $K) (Unconstrained Case)

	NSTX UPGRADE CONCEPTUAL DESIGN COST ESTIMATE								Recommended		CONCEPTUAL DESIGN	
	UNCONSTRAINED CASE				Uncertainty %		Risk		Contingency		ESTIMATE RANGE	
Review Committee	DESCRIPTION	RLM	Job Manager	Base Estimate	Low	High	Gross risk $ (4)	Likelyhood	Lower = (2)+(5)	Upper = (3)+(4)	LOWER	UPPER
Nelson/McManamy	Job: 1000 - CSU Analytical Support	Larry Dudek	Pete Titus	$421	-20%	40%			$42	$168	$463	$589
	Job: 1001 - CS Plasma Facing Components		Kelsey Tresemer	$1,776	-20%	40%	40	L	$195	$724	$1,971	$2,500
	Job: 1002 -Passive Plate Analysis & Upgrade Act		Pete Titus	$180	-20%	40%	-		$18	$72	$197	$251
	Job: 1200 - Vacuum Vessel & Structural Support		Danny Mangra	$779	-20%	40%	60	U	$36	$143	$815	$922
	Job: 1201 - Outer TF Structures		Danny Mangra	$701	-20%	40%	-		$70	$280	$771	$981
	Job: 1202 - Outer PF Coil Structures		Danny Mangra	$1,128	-20%	40%	-		$113	$451	$1,241	$1,580
	Job: 1203 - Umbrella Structural Reinforcement		Danny Mangra	$289	-20%	40%	-		$29	$115	$317	$404
	Job: 1204 - CS Support Pedestal		Danny Mangra	$203	-20%	40%	-		$20	$81	$223	$284
	Job: 1205 - Misc VV Structural Support		Danny Mangra	$256	-20%	40%	-		$26	$102	$282	$358
	Job: 1301 - Outer Toroidal Field Coils (incl 1300 CAD sprt)		Jim Chrzanowski	$726	-10%	15%	240	U	$78	$349	$804	$1,075
	Job: 1303 - TF Joint Test Stand & Perform Test		Tom Kozub	$338	-15%	25%	15	VU	$18	$100	$356	$438
	Job: 1304 - Inner TF Bundle (Dsgn/Fab)		Jim Chrzanowski	$1,935	-20%	40%	165	U	$235	$939	$2,170	$2,874
	Job: 1305 - OHMIC Heating Coil (OH) DSGN/FAB		Jim Chrzanowski	$4,004	-20%	40%	550	U	$432	$1,729	$4,436	$5,733
	Job: 1306 - Inner Poloidal Field Coils (Shaping)		Jim Chrzanowski	$536	-20%	40%	125	U	$85	$339	$621	$875
	Job: 1307 - CS Casing Assembly (DSGN/FAB)		Jim Chrzanowski	$892	-20%	40%	-		$89	$357	$981	$1,249
	Job: 1302 - Center Stack Assembly		Jim Chrzanowski	$833	-20%	40%	-		$83	$333	$917	$1,166
	Job: 2300 ECH Analysis		Jim Chrzanowski	$183	-20%	40%	100	U	$43	$173	$227	$357
Kellman/Greenfield	Job: 2420 - 2nd NBI Sources	Tim Stevenson	Mark Cropper	$1,398	-5%	10%	-		$35	$140	$1,433	$1,538
	Job: 2425 - BL Relocation		Martin Denault	$1,707	-15%	25%	-		$85	$423	$1,792	$2,131
	Job: 2430 - 2nd NBI Decontamination		Tim Stevenson	$2,738	-20%	10%	-		-$75	$150	$2,663	$2,888
	Job: 2440 - 2nd NBI Beamline		Martin Denault	$2,534	-10%	15%	(184)	L	-$48	$192	$2,486	$2,726
	Job: 2450 - 2nd NBI Services		Martin Denault	$3,601	-15%	25%	50	U	$189	$931	$3,789	$4,532
	Job: 2460 - 2nd NBI Armor		Craig Priniski	$420	-10%	15%	-		$10	$58	$430	$478
	Job: 2470 - 2nd NBI Power		Raki Ramakrishnan	$3,033	-15%	25%	50	U	$158	$779	$3,191	$3,812
	Job: 2475 - 2nd NBI Controls		Mark Cropper	$1,769	-15%	25%	-		$88	$442	$1,858	$2,212
	Job: 2480 - 2nd NBI/TVPS Duct		Craig Priniski	$2,665	-10%	15%	125	L	$137	$497	$2,802	$3,163
	Job: 2485 - Vacuum Pumping System		Craig Priniski	$319	-5%	10%	-		$8	$32	$327	$351
	Job: 2490 - NTC Equipt Relocations		Erik Perry	$3,314	-20%	40%	366	U	$409	$1,634	$3,723	$4,949
McManamy/Nelson	Job: 3200 - Water Cooling System Mods for CSU	Larry Dudek	Martin Denault	$394	-15%	25%	-		$19	$97	$413	$491
	Job: 3300 - Bakeout System Mods for CSU		Raki Ramakrishnan	$82	-5%	10%	-		$2	$8	$84	$91
	Job: 3400 - Gas Delivery System Mods for CSU		Bill Blanchard	$91	-15%	25%	10	VU	$5	$33	$96	$123
	Job: 4100 - Center Stack Diagnostics for CSU		Bob Kaita	$888	-5%	10%	-		$22	$88	$909	$975
	Job: 5000 - CSU Power Systems		Raki Ramakrishnan	$8,978	-15%	25%			$430	$2,148	$9,408	$11,126
	Job: 5501 - Coil Bus Runs		Jim Chrzanowski	$725	-20%	40%	-		$73	$290	$798	$1,015
	Job: 6100 - Control Sys & Data Acquisition Sys		Paul Sichta	$811	-15%	25%	253	U	$104	$456	$915	$1,267
Haines/Crescenzo	Job: 7100 - Project Mgt & Integration CSU & NBI	Ron Strykowsky	Ron Strykowsky	$4,536	-15%	25%	150	U	$233	$1,128	$4,769	$5,664
	Job: 7200 - Center Stack Management		Larry Dudek	$1,381	-15%	25%	107	U	$96	$452	$1,477	$1,833
	Job: 7300 - NB2 Management		Tim Stevenson	$1,679	-15%	25%	75	U	$100	$479	$1,778	$2,157
	Job: 7400 - Health Physics Support		Tim Stevenson	$2,768	-15%	25%	35	L	$159	$727	$2,927	$3,494
	JOB: 7700 - NSTX Upgrade HP Allocations		Ron Strykowsky	$1,755	-15%	25%	70	L	$130	$509	$1,885	$2,264
	Job: 7710 - Upgrade Allocations		Ron Strykowsky	$918	-15%	25%	20	L	$32	$118	$950	$1,036
Nelson/ McManamy	Job; 8200 - Centerstack & Coil Structural Instal	Larry Dudek	Mike Viola	$5,745	-20%	40%	370	U	$667	$2,668	$6,412	$8,413
	Job: 8250 - Remove/Install Centerstack		Mike Viola	$755	-30%	60%	196	U	$162	$649	$918	$1,404
Haines/ Crescenzo	Job: 7900 - Integrated System		Charlie Gentile	$71	-20%	40%	-		$7	$29	$79	$100
	schedule (months)			48		7.2			$1,746	$1,746	$1,746	$1,746
	Base Estimate =			$70,254			2,988		$6,594	$23,360	$76,848	$93,614
	etc=			$65,108					10%	36%		

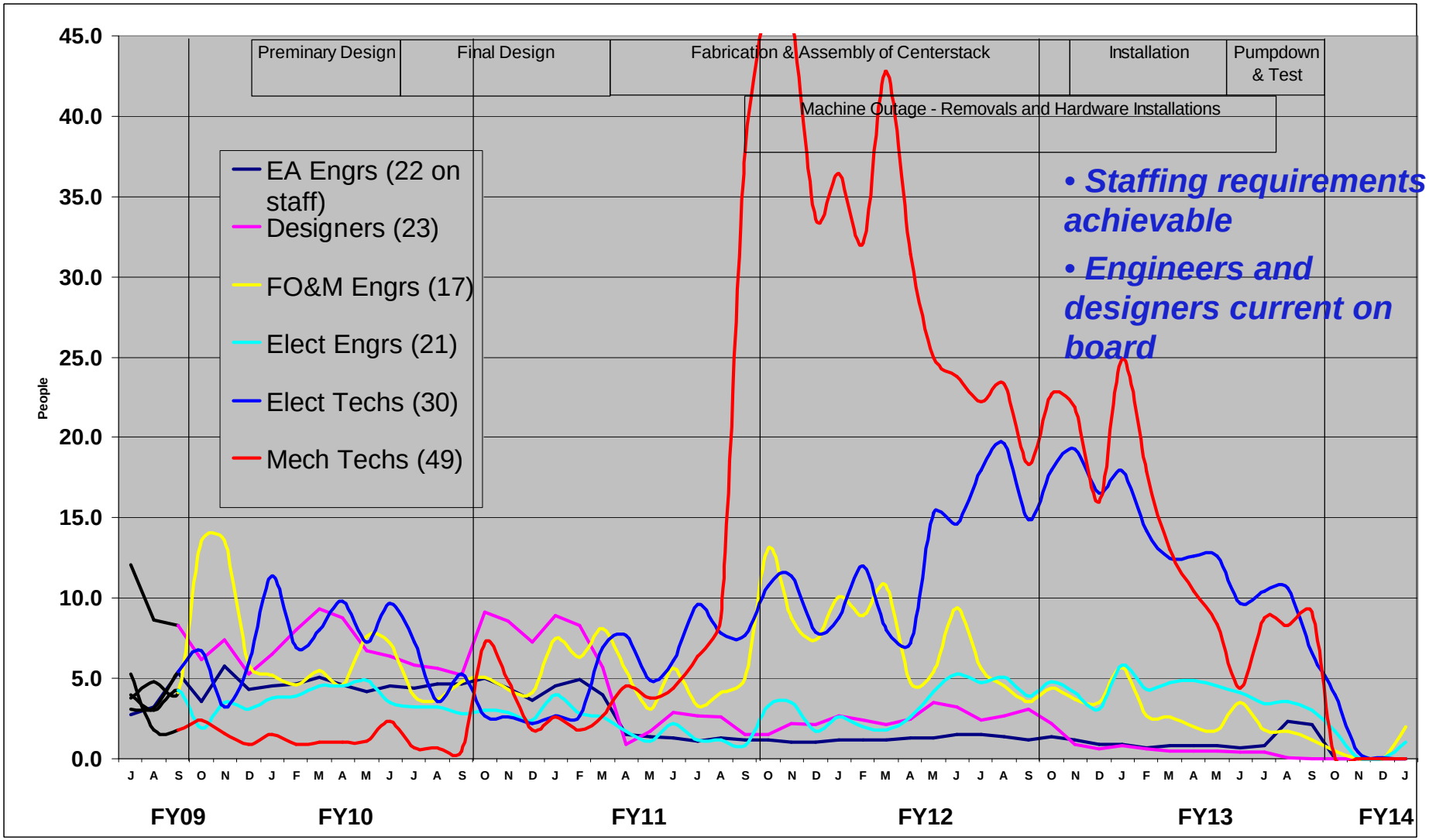
- **Base Estimate = $70.3M**
- **Contingency = 10% - 36%**
- **TPC range = $76.8M - $93.6M**
- **Schedule Contingency = 7.2months**

Project Funding Requirements



- ***Unconstrained case consistent with CD-0 proposed schedule***
- ***Constrained case approximates anticipated program funding guidance with a one year slip and $4M impact.***

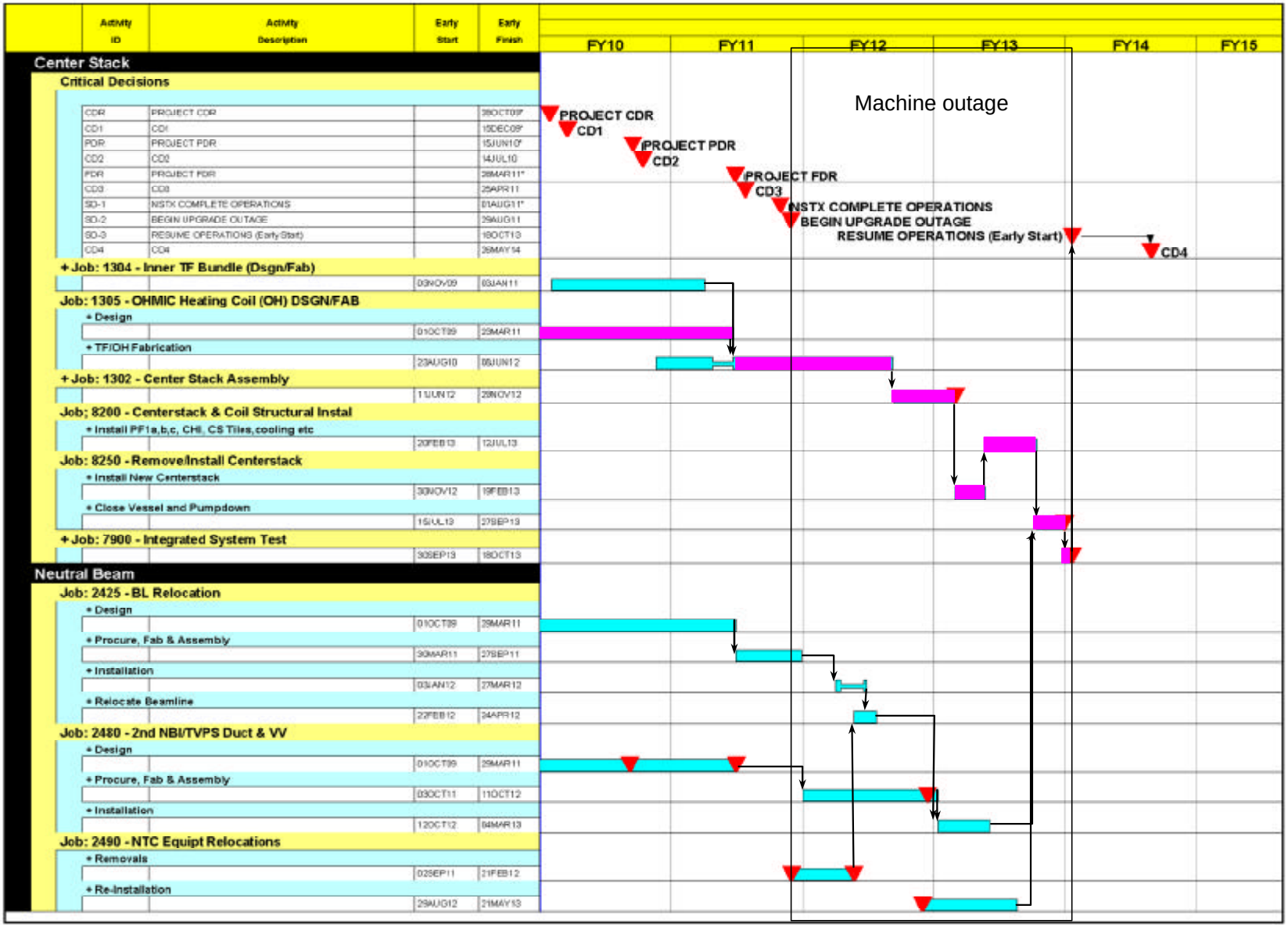
Project Staffing Requirements-Long Range Skill Needs
(unconstrained case)



Project Staffing Requirements-Short Term People Needs

			Preliminary Design								Final Design								
Name		Job	NOV FY10	DEC FY10	JAN FY10	FEB FY10	MAR FY10	APR FY10	MAY FY10	JUN FY10	JUL FY10	AUG FY10	SEP FY10	OCT FY11	NOV FY11	DEC FY11	JAN FY11	FEB FY11	MAR FY11
AVASARALA	EA Engr	Job: 1002 -Passive Plate Analysis & Upgrade Act	0.33	0.30	0.36	0.36	0.41	0.39	0.36	0.42	0.41	0.42	0.41	0.41	0.39	0.33	0.41	0.39	0.31
BROOKS	EA Engr	Job: 1002 -Passive Plate Analysis & Upgrade Act	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.02
BRYANT	EA Engr	Job: 2300 - ECH Analysis	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01
CHRZANOWSKI	EA Engr	Job: 1301 - Outer Toroidal Field Coils	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06	0.22
CHRZANOWSKI	EA Engr	Job: 1302 - Center Stack Assembly	-	-	-	-	-	-	-	-	-	-	-	0.09	0.09	0.08	0.09	0.09	0.13
CHRZANOWSKI	EA Engr	Job: 1307 - CS Casing Assembly (DSGN/FAB)	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.13	0.13	0.13	0.13	0.13	0.12	0.10	0.13	0.12	0.24
CHRZANOWSKI	EA Engr	Job: 1306 - Inner Poloidal Field Coils (Shaping)	0.12	0.11	0.13	0.13	0.16	0.14	0.13	0.11	0.10	0.10	0.10	0.10	0.10	0.08	0.10	0.10	0.19
CHRZANOWSKI	EA Engr	Job: 1305 - OHMIC Heating Coil (OH) DSGN/FAB	0.21	0.20	0.23	0.23	0.27	0.26	0.23	0.21	0.20	0.21	0.20	0.20	0.20	0.17	0.20	0.20	0.43
CHRZANOWSKI	EA Engr	Job: 1304 - Inner TF Bundle (Dsgn/Fab)	0.43	0.40	0.47	0.47	0.53	0.51	0.47	0.11	0.03	0.03	0.03	0.23	0.07	0.04	0.06	0.06	0.38
			0.80	**0.74**	**0.88**	**0.88**	**1.00**	**0.96**	**0.88**	**0.57**	**0.47**	**0.48**	**0.47**	**0.76**	**0.58**	**0.47**	**0.58**	**0.62**	**1.60**
EA//EM	EA Engr TBD	Job: 2480 - 2nd NBI/TVPS Duct	-	-	-	-	-	-	-	-	0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02
EA//EM	EA Engr TBD	Job: 1305 - OHMIC Heating Coil (OH) DSGN/FAB	-	-	-	-	-	-	-	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.02
EA//EM	EA Engr TBD	Job: 1001 - CS Plasma Facing Components	-	-	-	-	-	-	-	-	0.06	0.19	0.18	0.13	-	-	-	-	-
EA//EM	EA Engr TBD	Job: 5501 - Coil Bus Runs	-	-	-	-	-	-	-	0.10	0.10	0.11	0.10	0.10	0.10	0.09	0.10	0.10	0.08
EA//EM	EA Engr TBD	Job: 3200 - Water Cooling System Mods for CSU	-	-	0.22	0.37	0.24	-	-	-	-	-	-	-	0.04	0.07	0.09	0.08	-
EA//EM	EA Engr TBD	Job: 1000 - CSU Analytical Support	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.37	0.36	0.37	0.36	0.36	0.33	0.29	0.36	0.33	0.26
EA//EM	EA Engr TBD	Job: 2460 - 2nd NBI Armor	0.17	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EA//EM	EA Engr TBD	Job: 2480 - 2nd NBI/TVPS Duct	-	-	0.11	0.09	0.06	-	-	-	-	-	-	-	-	-	-	-	-
EA//EM	EA Engr TBD	Job: 2450 - 2nd NBI Services	0.50	0.33	-	-	-	-	-	-	-	-	-	-	-	-	-	0.56	-
EA//EM	EA Engr TBD	Job: 2425 - BL Relocation	1.00	0.39	-	-	-	-	-	-	-	-	0.18	0.29	0.09	-	-	-	-
			1.69	**0.79**	**0.37**	**0.49**	**0.33**	**0.03**	**0.03**	**0.50**	**0.56**	**0.72**	**0.87**	**0.93**	**0.62**	**0.48**	**0.60**	**1.12**	**0.38**
ELLIS	EA Engr	Job: 2300 - ECH Analysis	0.12	0.11	0.12	0.12	0.14	0.13	0.12	0.13	0.13	0.13	0.13	0.13	0.12	0.11	0.13	0.12	0.04
			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MANGRA	EA Engr	Job: 1200 - Vacuum Vessel & Structural Support	0.31	0.01	0.07	0.08	0.09	0.09	0.08	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02
MANGRA	EA Engr	Job: 1205 - Misc VV Structural Support	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.11	0.11	0.11	0.11	0.11	0.10	0.09	0.11	0.10	0.09
MANGRA	EA Engr	Job: 1203 - Umbrella Structural Reinforcement	0.09	0.09	0.10	0.10	0.11	0.11	0.10	0.13	0.13	0.13	0.13	0.13	0.12	0.11	0.13	0.12	0.10
MANGRA	EA Engr	Job: 1201 - Outer TF Structures	0.09	0.09	0.10	0.10	0.11	0.11	0.10	0.20	0.19	0.20	0.19	0.19	0.18	0.16	0.19	0.18	0.14
MANGRA	EA Engr	Job: 1204 - CS Support Pedestal	0.11	0.10	0.12	0.12	0.13	0.13	0.12	0.16	0.14	0.16	0.14	0.14	0.14	0.12	0.14	0.14	0.11
MANGRA	EA Engr	Job: 1202 - Outer PF Coil Structures	0.23	0.22	0.26	0.26	0.30	0.28	0.26	0.34	0.33	0.36	0.33	0.33	0.32	0.27	0.33	0.32	0.26
			0.87	**0.54**	**0.69**	**0.70**	**0.79**	**0.77**	**0.70**	**0.98**	**0.93**	**0.98**	**0.93**	**0.93**	**0.89**	**0.76**	**0.93**	**0.89**	
MYATT	EA Engr	Job: 1307 - CS Casing Assembly (DSGN/FAB)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.09	0.09	0.09	0.09	0.09	0.09	0.07	0.09	0.09	0.07
RAFTOPOUIOS	EA Engr	Job: 5501 - Coil Bus Runs	0.27	0.26	0.30	0.30	0.34	0.32	0.30	0.23	0.22	0.23	0.22	0.22	0.21	0.18	0.22	0.21	0.17
			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIMMONS	EA Engr	Job: 1000 - CSU Analytical Support	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-
SIMMONS	EA Engr	Job: 1304 - Inner TF Bundle (Dsgn/Fab)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
SIMMONS	EA Engr	Job: 1305 - OHMIC Heating Coil (OH) DSGN/FAB	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
SIMMONS	EA Engr	Job: 2300 - ECH Analysis	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.01
SIMMONS	EA Engr	Job: 7100 - Project Mgt & Integration CSU & NBI	0.19	0.17	0.20	0.20	0.22	0.21	0.20	0.21	0.20	0.21	0.17	0.20	0.19	0.17	0.20	0.19	0.22
			0.26	**0.23**	**0.27**	**0.27**	**0.29**	**0.28**	**0.27**	**0.28**	**0.27**	**0.28**	**0.23**	**0.27**	**0.26**	**0.23**	**0.27**	**0.26**	**0.26**
TITUS	EA Engr	Job: 1201 - Outer TF Structures	0.11	0.10	0.12	0.12	0.13	0.13	0.12	0.18	0.18	0.19	0.18	0.18	0.17	0.14	0.18	0.17	0.13
TITUS	EA Engr	Job: 1304 - Inner TF Bundle (Dsgn/Fab)	0.16	0.13	0.16	0.16	0.18	0.18	0.16	0.12	0.12	0.12	0.12	0.12	0.11	0.10	0.12	0.11	0.37
TITUS	EA Engr	Job: 1202 - Outer PF Coil Structures	0.21	0.20	0.23	0.23	0.27	0.26	0.23	0.20	0.19	0.20	0.19	0.19	0.18	0.16	0.19	0.18	0.14
TITUS	EA Engr	Job: 1000 - CSU Analytical Support	0.32	0.30	0.36	0.36	0.41	0.39	0.36	0.29	0.28	0.29	0.28	0.28	0.27	0.22	0.28	0.27	0.20
			0.80	**0.73**	**0.87**	**0.87**	**0.99**	**0.96**	**0.87**	**0.79**	**0.77**	**0.80**	**0.77**	**0.77**	**0.72**	**0.62**	**0.77**	**0.72**	**0.84**
ZHANG	EA Engr	Job: 1202 - Outer PF Coil Structures	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-	-	-	-	-	-	-	-	-	-
ZHANG	EA Engr	Job: 1204 - CS Support Pedestal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ZHANG	EA Engr	Job: 1304 - Inner TF Bundle (Dsgn/Fab)	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.02
ZHANG	EA Engr	Job: 1201 - Outer TF Structures	0.11	0.10	0.12	0.12	0.13	0.13	0.12	0.01	-	-	-	-	-	-	-	-	-
ZHANG	EA Engr	Job: 1203 - Umbrella Structural Reinforcement	0.07	0.07	0.08	0.08	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.06	0.08	0.07	0.06
ZHANG	EA Engr	Job: 2300 - ECH Analysis	0.16	0.13	0.16	0.16	0.18	0.18	0.16	0.18	0.17	0.18	0.17	0.17	0.16	0.13	0.17	0.16	0.06
			0.39	**0.36**	**0.42**	**0.42**	**0.47**	**0.47**	**0.42**	**0.30**	**0.28**	**0.29**	**0.28**	**0.28**	**0.26**	**0.21**	**0.28**	**0.26**	**0.13**
ZOLFAGHARI	EA Engr	Job: 1306 - Inner Poloidal Field Coils (Shaping)	-	-	-	-	-	-	-	0.06	0.06	0.07	0.06	0.06	0.06	0.04	0.06	0.06	0.04
ZOLFAGHARI	EA Engr	Job: 1305 - OHMIC Heating Coil (OH) DSGN/FAB	0.17	0.16	0.19	0.19	0.21	0.21	0.19	0.14	0.13	0.14	0.13	0.13	0.13	0.11	0.13	0.13	0.10
			0.17	**0.16**	**0.19**	**0.19**	**0.21**	**0.21**	**0.19**	**0.20**	**0.19**	**0.21**	**0.19**	**0.19**	**0.19**	**0.16**	**0.19**	**0.19**	**0.14**

Project Schedule (Unconstrained Case)



Major Procurements
(unconstrained case)

(Procurements > $100,000)

Job:	Description	Award/Begin Work		Amount
Job: 1304 - Inner TF Bundle (Dsgn/Fab)	Manufacture Inner TF Copper extrusions [80]	FY10	15-Mar-10	$ 242,000
Job: 1304 - Inner TF Bundle (Dsgn/Fab)	Machine Inner TF conductors [grooves, lead area]	FY10	21-Jul-10	$ 250,000
Job: 1305 - OHMIC Heating Coil (OH) DSGN/FAB	Manufacture OH Copper conductor [extrusion]	FY11	08-Oct-10	$ 105,600
Job: 1304 - Inner TF Bundle (Dsgn/Fab)	Friction Stir-Weld coil leads conductors- 40	FY11	21-Oct-10	$ 250,000
Job: 2450 - 2nd NBI Services	Ion Dump Water Lines	FY11	01-Jul-11	$ 135,000
Job: 5000 - CSU Power Systems	531- FCPC DC Systems -Procure 1000MCM Cable & Tr	FY11	10-Aug-11	$ 143,000
Job: 5000 - CSU Power Systems	531- FCPC DC Systems -Procure OH Reactors	FY11	10-Aug-11	$ 100,000
Job: 1201 - Outer TF Structures	Fabricate Outer TF Structure components	FY11	15-Aug-11	$ 297,600
Job: 1306 - Inner Poloidal Field Coils (Shaping)	Fabricate Inner [6] Inner PF coils	FY11	19-Aug-11	$ 180,000
Job: 1001 - CS Plasma Facing Components	Fabricate or delivery - PFC Tiles	FY11	30-Aug-11	$ 650,000
Job: 1001 - CS Plasma Facing Components	Fab or delivery PFC Hardware & Materials	FY12	03-Oct-11	$ 150,000
Job: 5000 - CSU Power Systems	541 - Electrical Interlocks -Procurement PLC	FY12	03-Oct-11	$ 102,000
Job: 5000 - CSU Power Systems	544 -PC Link/FD/FG changes -Procure control link	FY12	03-Oct-11	$ 740,000
Job: 5000 - CSU Power Systems	545 - Instrumentation -Procure Transducers	FY12	03-Oct-11	$ 229,000
Job: 5000 - CSU Power Systems	MPS -Procurement	FY12	03-Oct-11	$ 298,000
Job: 2480 - 2nd NBI/TVPS Duct	Fabricate / Delivery - NBI RWM Coil	FY12	05-Oct-11	$ 170,000
Job: 2475 - 2nd NBI Controls	Fabricate or delivery 2nd NBI Controls	FY12	18-Oct-11	$ 312,000
Job: 1202 - Outer PF Coil Structures	Fabricate Outer PF Cage [PF-3/4/5]	FY12	08-Nov-11	$ 350,000
Job: 1202 - Outer PF Coil Structures	Fabricate PF-2/PF-1c support modifications	FY12	09-Nov-11	$ 118,800
Job: 2480 - 2nd NBI/TVPS Duct	Fabricate / Delivery - NBI 40" VAT Valves (2)	FY12	11-Nov-11	$ 250,000
Job: 2450 - 2nd NBI Services	HVE Water Lines	FY12	15-Nov-11	$ 100,000
Job: 2480 - 2nd NBI/TVPS Duct	Fabricate / Delivery - NBI 40" Bellows Section	FY12	15-Nov-11	$ 300,000
Job: 2470 - 2nd NBI Power	Procurement/Fab/Assembly - 2nd NBI Cables	FY12	18-Nov-11	$ 422,200
Job: 5000 - CSU Power Systems	531- FCPC DC Systems - Instl cable & misc h/w	FY12	01-May-12	$ 535,000
Job: 2470 - 2nd NBI Power	Installation - 2nd NBI Raceway	FY12	09-Apr-12	$ 480,000

- *Center stack Hardware on or near critical path*
- *Required before CD-3 (April 2011)*

Management Process

The NSTX Upgrade project will be managed using PPPL's cost and schedule control processes

(Project Management System Program Description (PMSPD) Revision 0 July 2009)

- **Adopt the conceptual design plan as our baseline through preliminary design (CD-2) (will adjust in response to CDR and OFES findings)**
- **Monthly progress measurement including;**
  - **Earned value**
  - **Risk registry review**
  - **EAC assessment**
- **Monthly reporting including**
  - **Status barcharts**
  - **Cost performance reports (CPR's) including EAC's**
  - **Updated risk registry**
- **Change control process – changes documented via engineering change proposals (ECP's)**

Conclusions

Is the proposed cost and schedule range, including contingency, realistic and reasonable?

- ***The work scope is complete, well organized with clear assignment of responsibilities.***
- ***Estimates based upon a standardized and disciplined process***
- ***A well detailed resource loaded schedule exists and provides the basis for all cost and schedules***
- ***A well detailed risk registry has been developed and implemented***
- ***The contingency methodology incorporates estimate uncertainty as well as risk and provides a credible CD-1 cost range.***
- ***Both the unconstrained and constrained case's staffing needs are well identified and achievable.***
- ***The project has been responsive in addressing both programmatic mission goals (base case) as well as anticipated funding guidance (constrained case).***
- ***The project is poised to initiate and effectively manage the preliminary design phase of the project.***