

NCSX CLOSE OUT NOTE: JOB 1701

TO: Phil Heitzenroeder
FROM: Fred Dahlgren

SUBJECT: Base Support Structure Job-1702

Date: 10/07/2008

Scope

This job covers the design and analysis of the base structural supports for the NCSX machine core, including the short column weldments which interface the core to the base support structure. Completion of this job is required prior to the start of component procurements in job 1701.

Status

This job has completed an FDR and includes a complete set of drawings and bill of materials ready for procurement & fabrication as well as documentation of the analysis in support of the design.

Interfaces

Key interfaces include the PF & TF coil mounting brackets, the cryostat lower seals, and the test cell floor. AC power will be required for the upper heater elements, thermocouples, and strain gages. Other instrumentation leads TBD may also utilize portions of these structures for support brackets.

Specifications

A formal FMECA was not anticipated but a failure mode and mitigation plan was included in the PDR.

Schematics and PIDs

N/A

Models

full-base-suppt-model-F4j2.db

Drawings

Top Assembly Drawings:

se172-201-rev0 Base Support Assembly Test Cell

se172-203-rev0 Center Support Base Weldment

se172-207-rev0 Base Weldment

se172-219-rev0 Outer column Upper Support Assembly

se172-244-rev0 Inner Column Upper Support Assembly

se172-245-rev0 Support Column Joint Spherical Bearing Housing Assembly

Note: detail drawings, and sub-assemblies can be found on the parts list of the main assemblies cited above or the full listing on the BOM.

NCSX CLOSE OUT NOTE: JOB 1701

Analysis

NCSX-CALC-17-001-00

Testing

The only testing performed was verification of magnetic permeability of commercially procured parts specified on the BOM. Samples of all parts specified meet the project permeability requirements in the locations they are to be used (as specified in the GRD).

Costs

The initial budgetary quotes received for fabrication of this job were based on purchased stainless 304L structurals and cutting and welding in our shops (as of 4/21/2008) and will need to be escalated based on current market conditions and labor rates. This was done for the most recent Lehman review but would need to be re-visited were this project to be re-started. Hardware costs in the latest estimates (04/21/2008) are current as of that date as are material costs.

Remaining Work

All chits from the PDR were resolved prior to the FDR and their status updated at that time. There were 3 chits from the FDR which remain unresolved pending input from other subsystems.

A detailed analysis of the local bolting stresses to resolve any issues there (use of 316 hardware versus 718 Inconel at some locations may save costs), is also pending and would be recommended prior to fabrication. A revisiting the anchor bolt stresses which includes the seismic loading from the global model is also recommended (loads presented at the FDR for static seismic runs utilized a lumped mass approximation which should be validated with load results from the global model seismic runs).

Incorporation of the local models of the TF pre-load ring and CS structure into the full global model and a more thorough analysis of fault loading conditions on the CS and other coil systems is TBD (while not essential since the loads and weight of the C.S. has been included in all the global analyses for the FDR, a more complete fully integrated model with credible fault loads would be desirable).

Lessons Learned:

Nobody has a crystal ball, but cost estimating based strictly on current commodity prices without a sizable escalator for inflation is unwise –particularly in the present economic climate. These escalators should be in addition to any project contingency.

Conclusion: *A detailed analysis of the most critical bolted connections should be performed which could permit the use of 316 bolting hardware in many locations with Inconel 718 hardware used only where needed. This could reduce costs for bolting materials by 50% or more. Full solution annealing of 304L can lower the permeability of cold worked and welded 304L and should be considered if permeability issues arise. The current GRD requirement for magnetic permeability at the base support structure is 1.05. The base support design as presented at the FDR and documented in the reference drawings will meet these requirements.*

PF, TF, & Trim Coil Supports (WBS-15) Core Base Support Structure (WBS-17)

F. Dahlgren

NCSX Coil & Core base support structures

Requirements:



PF, TF, Trim Coil Supports

The coil support structure provides the means for accurately locating and supporting the TF, PF, & Trim coils.

- It must provide adequate support for the EM loads arising from the coil operational scenarios and fault conditions.
- It must have sufficient compliance to accommodate cooldown from room temperature to 77 deg.K
- It must be sufficiently rigid to limit coil deflections to acceptable values per field error criteria.
- It must have a relative magnetic permeability less than 1.02
- It must limit eddy currents to effectively limit field errors at the plasma boundary.
- It must meet the NCSX seismic & Structural Design Criteria.



Requirements:



Base Support Structure

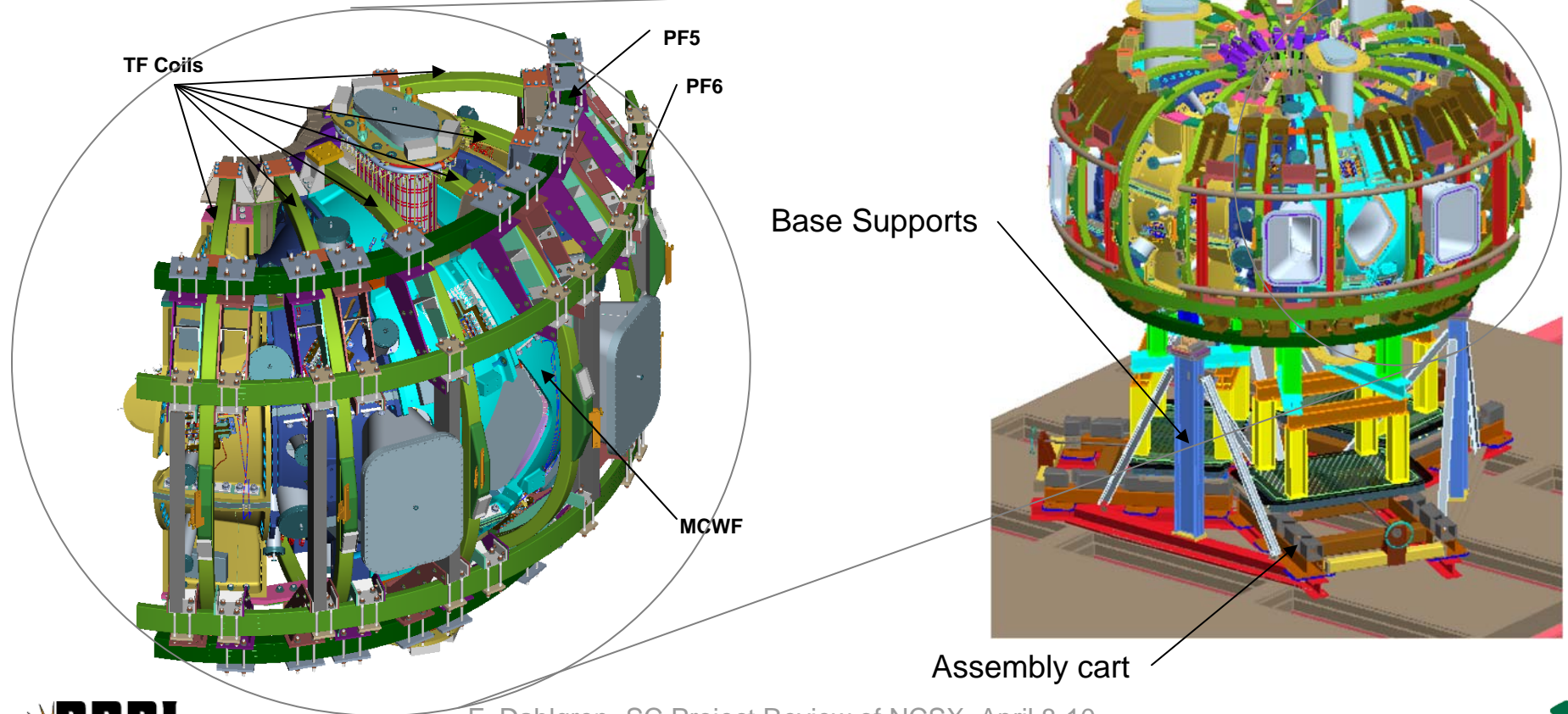
Functional requirements:

- Provides the gravity load path from the NCSX core to the test cell floor.
- It must not exceed the maximum test cell floor loading of 4,500 lbs/sq.ft.
- It must have a relative magnetic permeability less than 1.05
- It must meet the NCSX Structural Design & Seismic Criteria.
- It must provide support & clearance for the three period assembly tooling.

Interfaces

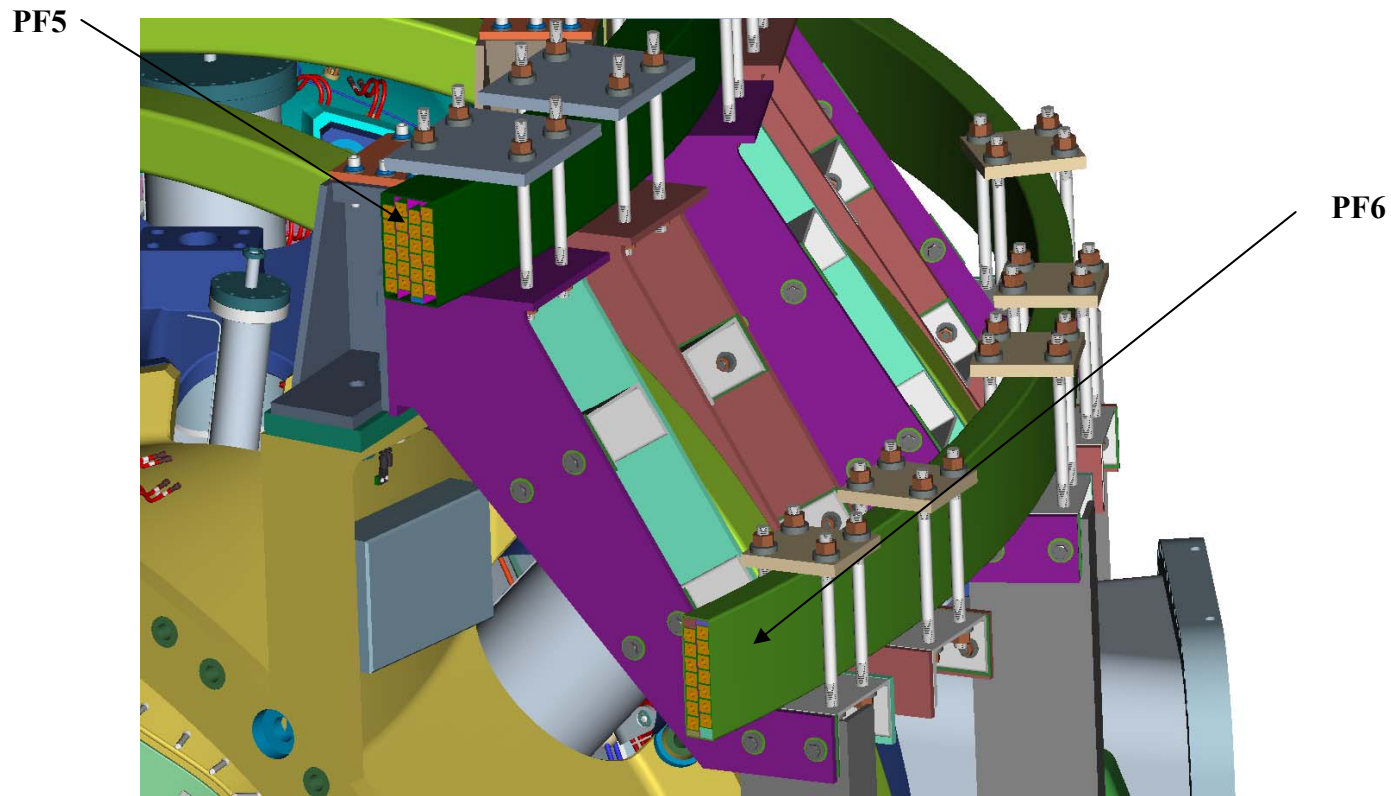
PF, TF, & Trim Coil Supports

The coil supports interface with the MCWF shell which provides the load path to react all coil EM and gravity loads. It will also interface with the mounting hardware for supporting the coil buswork, cryogen lines & cryostat.



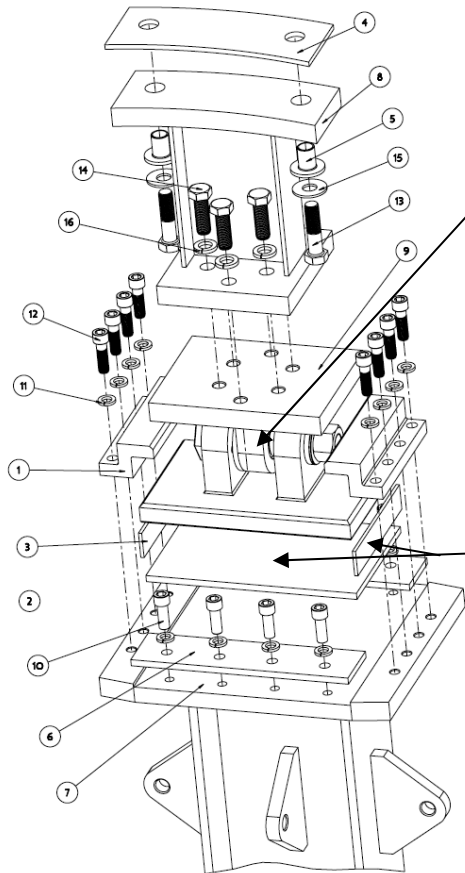
Interfaces

PF5 & 6 support brackets are cantilevered off the TF outer brackets



Interfaces

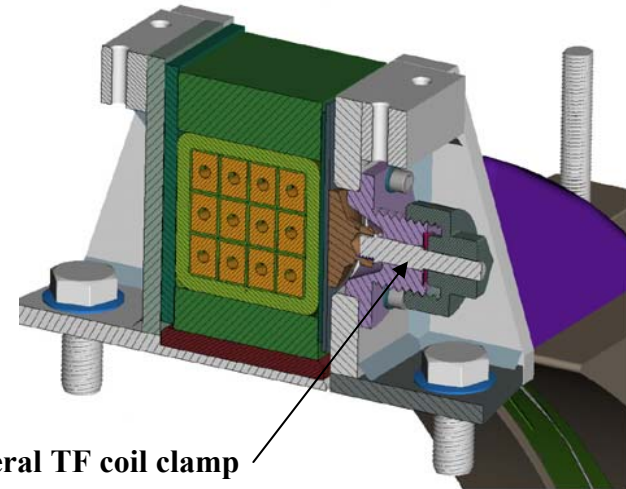
The interface between the MCWF and Base Support columns



Spherical Bearings provide translational connections and avoid introduction of rotational moments on the MCWF shell.

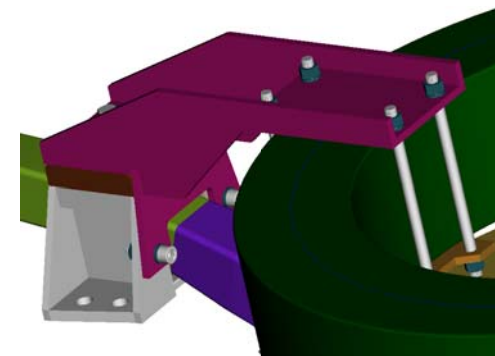
Low friction PTFE sheets provide a low compliance radial interface to allow for differential thermal contraction from room temperature base supports to 77 K core.

TF Coil bracket & clamp interface



Lateral TF coil clamp

PF4 Coil bracket & clamp interface



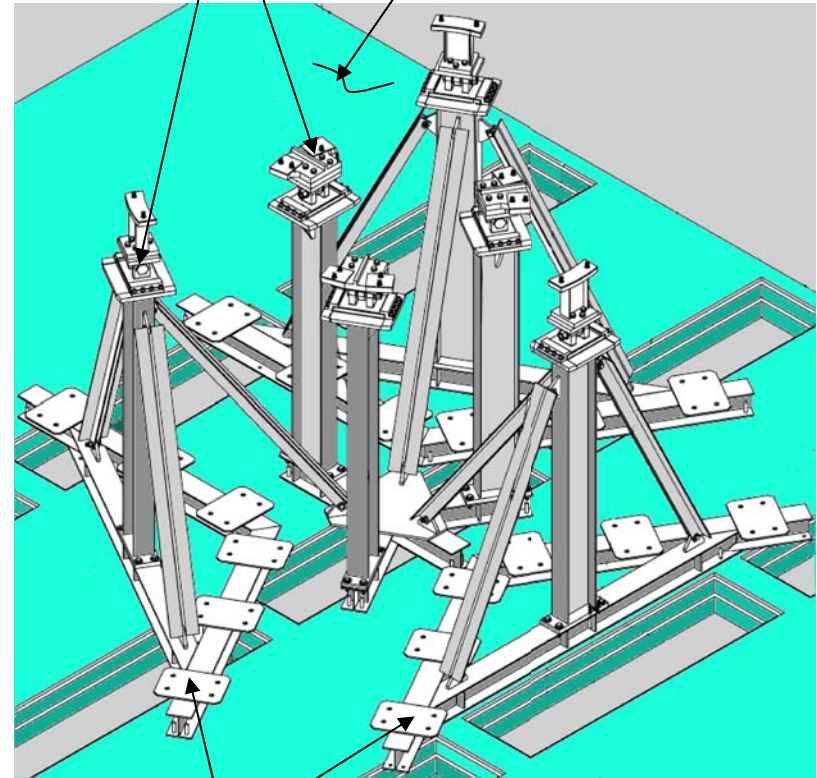
Interfaces

Base Support Structure

The base support structure interfaces with the test cell floor, and TF support brackets. It also provides the mounting pads for the three period assembly fixtures.

Spherical bearing Housings

Test cell floor
(rated @ 4500 psf)



Mounting pads for 3-period assembly cart rails

Design Status



PF,TF, & Trim Coil Supports

- Peer review held on 01/18/07
- PDR held on 07/20/07
- FDR scheduled for 06/16/08
- Pro-E design integration complete.
- Preliminary drawings issued for review.
- Minor revisions being implemented to accommodate trim coil support mounting hardware.
- Design in final detailing awaiting interface information for buswork, cryogen lines, and cryostat mounting hardware.
- FEA modeling utilizing a single period fully integrated model is complete.
- FEA analysis of various EM and fault loading conditions is underway (~ 30% complete) with the fully integrated FEA model.



Design Status



Base Support Structure

- Peer review held on 01/18/07
- PDR held on 03/06/08
- FDR scheduled for 04/30/08
- Pro-E design integration complete.
- Preliminary drawings issued for review.
- Minor revision to accommodate cryostat interface underway.
- FEA modeling (w/testcell floor & structure) complete.
- FEA analysis complete.



Procurement Plans



PF,TF, & Trim Coil Supports

- Current plan for a fixed price subcontract.
- At least two potential vendors have been identified and budgetary estimates have been received.
- RFQ & CSPEC are being prepared, with a projected procurement cycle of 6 weeks starting mid-July '08 (subsequent to FDR).

Base Support Structure

- Procure main columns & beams from Stainless Structural, LLC (~ 13 weeks)
- Fabricate parts in-house (welding, drilling, & assembly).



Cost & Schedule - Coil Supports



PF,TF, & Trim Coil Supports - Design

15 - Coil Structures								Cost to Complete	FY08			FY09			FY10			
Job: 1501 - Coil Structures Design-DAHLGREN																		
1501-533		Detail CAD Drawings,BOM	260*	01JUN07A	16JUN08	188	28,638.26											
1501-533F		Integrated Stress Analysis	176*	01OCT07A	16JUN08	188	27,007.75											
1501-536		Issue dwgs for review	0		01APR08*	215	0.00											
1501-535		Develop Interfaces with cryostat	0		01MAY08*	213	0.00											
1501-549		Update C.S.Support Attacgment Design	6	09MAY08	16MAY08	188	8,146.80											
1501-550		Peer review C.S.Design	5	19MAY08	23MAY08	188	1,168.88											
1501-554		Resolve CS peer review Chits	5	27MAY08	02JUN08	188	8,146.80											
1501-562		Prepare Specs for Coil Structure & CSS h/w	10	03JUN08	16JUN08	188	3,542.00											
1501-537		FDR Prep	6	09JUN08	16JUN08	188	3,515.48											
1501-541	3	Coil Support Structures - FDR	0		16JUN08	188	0.00											
1501-545		Resolve Chits	5	17JUN08	23JUN08	188	5,844.40											
1501-558		Prepare requisition for Coil Structure & CSS h/w	10	24JUN08	08JUL08	188	3,542.00											

PF,TF, & Trim Coil Supports - Fabrication/Procurement

Job: 1550 - Coil Struct. Procurement -PERRY								Cost to Complete	FY08			FY09			FY10			
1501-245		Solicit Bids, and Evaluate Bids	35	09JUL08	26AUG08	188	0.00											
162-036.9	2	Award Coil Support Structure	0		02SEP08*	184	0.00											
162-037		Fabricate structure components	100	03SEP08	02FEB09	184	1,142,011.99											
162-037M	2	Deliver Coil Structure components	0		02FEB09	184	0.00											
162-050		Prep req, bid and award G11/Teflon parts	25	01OCT08*	04NOV08	149	0.00											
162-051		Deliver G11/Teflon parts	90	05NOV08	23MAR09	149	153,879.66											
162-052		Prep req, bid and award Inconel hardware	25	01OCT08*	04NOV08	179	0.00											
162-053		Deliver Inconel hardware	60	05NOV08	09FEB09	179	106,586.37											
162-055		Prep req, bid and award Belleville Washers	25	01OCT08*	04NOV08	149	0.00											
162-057		Deliver Belleville Washers	90	05NOV08	23MAR09	149	24,422.20											
162-031		Title III engr WBS 151	117	03SEP08*	25FEB09	1,424	12,091.25											

Total: 1,439k\$ (FY'09)



Cost & Schedule - Base Support Structure



Base Support Structure - Design

Activity ID	MILE-STONE LEVEL	Activity Description	Duration (work days)	SHIFTS	Forecast Start	Forecast Finish	Total Float	Cost to Complete	FY		
									FY08	FY09	FY10
17 - Cryostat and Base Support Structure											
Job: 1702 - Base Support Struct Design-DAHLGREN											
1702-515	3	Base support - PDR	5	R	31JAN08	06FEB08	202	3,506.64			
1702-516	3	Disposition PDR chits	5	R	07FEB08	13FEB08	202	2,833.60			
1702-520		Final design. Assy dwgs, fab dwgs,	64*		01FEB08A	30APR08	147	127,230.72			
1702-521	2	Issue dwgs for comment	0			28MAR08*	170	0.00			
1702-525M	2	Base Support Structure FDR	0			30APR08	147	0.00			
1702-530		Resolve chits, issue dwgs for fab, issue requisit	10		01MAY08	14MAY08	147	8,430.08			

Base Support Structure - Fabrication

Job: 1752 - Base Support Proc-PERRY											
172 - Base Support Structure											
161-036.8	3	Bid and award base support materials	30		19AUG08*	30SEP08	177	0.00			
161-036.9	3	Deliver base support materials	130		01OCT08	13APR09	177	192,190.96			
161-037		PPPL assemble structure	40		14APR09*	09JUN09	177	30,335.91			
161-038		Title III	306		15MAY08*	05AUG09	1,311	7,037.18			

**Total: 229.5 k\$
(FY'09)**



Risks & Mitigation

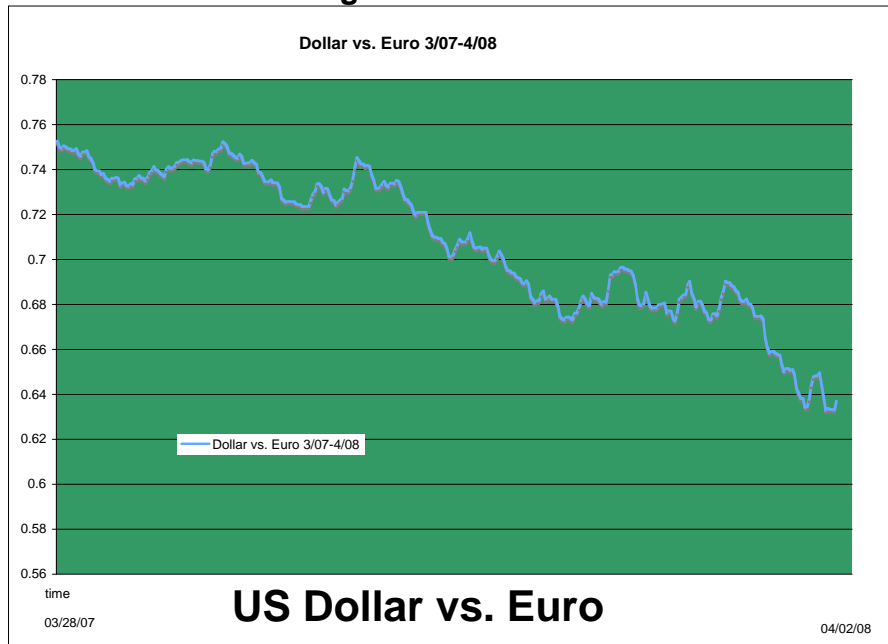


PF,TF, & Trim Coil Supports & Base Support Structure

Both these jobs are comprised of conventional weldments and bolted assemblies. As such they are classified as relatively low risk components with minimal probability of cost escalation or scheduler delay associated with their procurement and fabrication.

Risk:

The main source of cost escalation would be tied to increased commodity prices for Nickel and Molybdenum and the weakening value of US dollar vs. the Euro.



QuickTime™ and a TIFF (LZW) decompressor are needed to see this picture.

Nickel Price Since January

Mitigation:

Expedite procurement of stainless structurals and Inconel hardware.

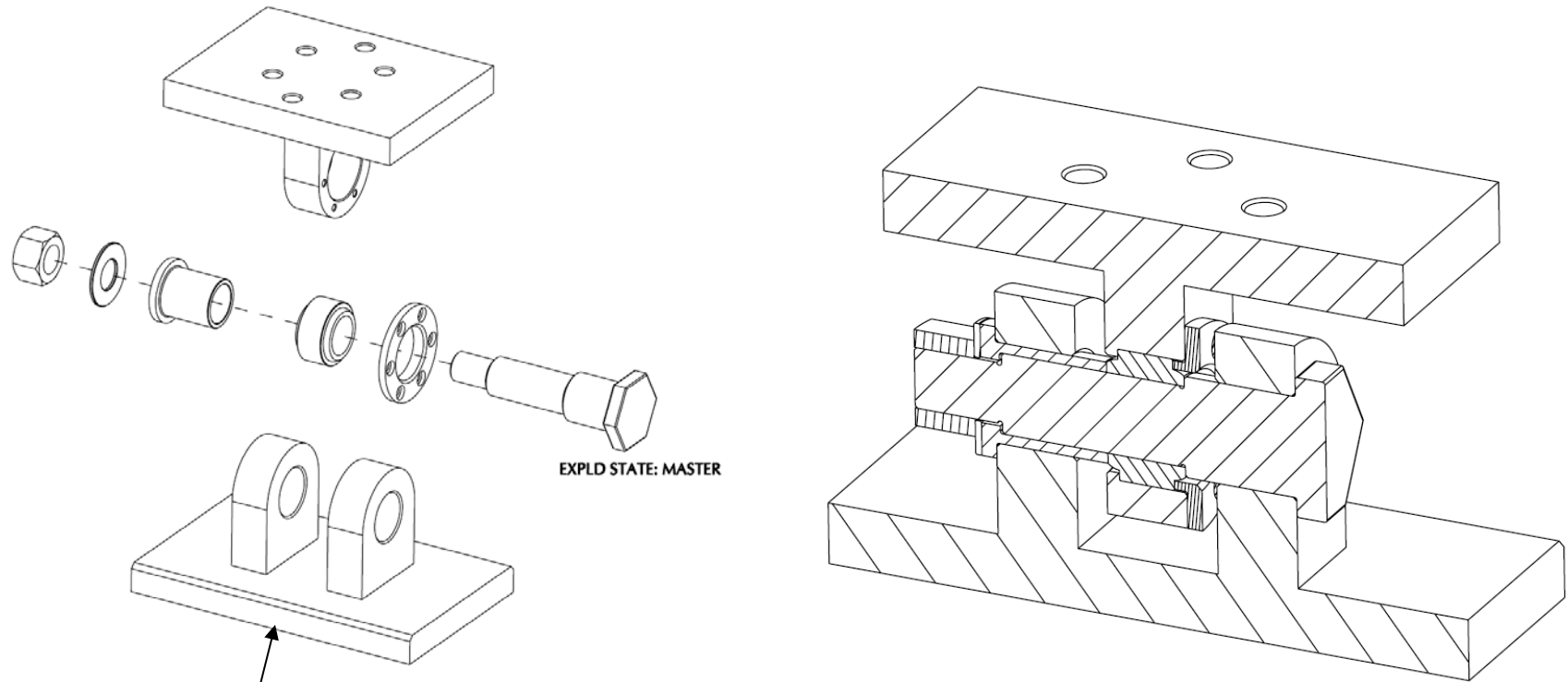


Backup slides

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.



Strip heaters (4 per column) will be used to maintain R.T. (40 to 60 F) of columns



Bottom surface slides on Teflon sheet

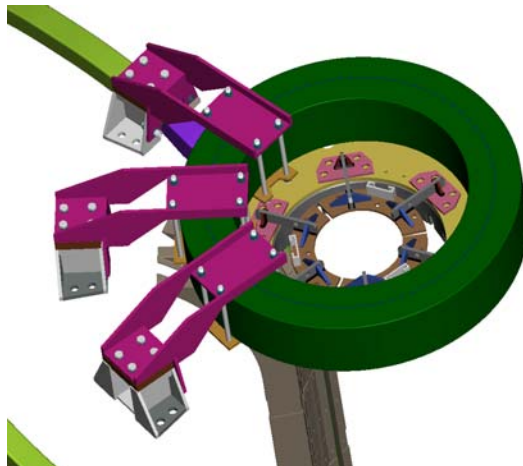


TF Inner Supports "B" to "C" Span

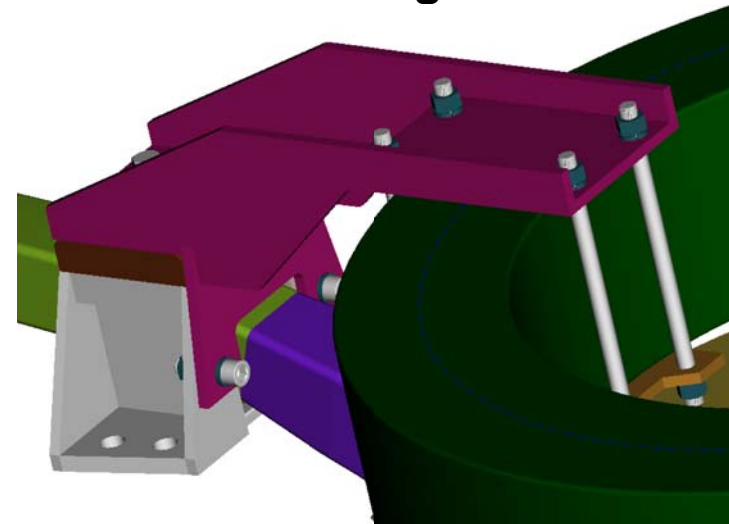


TF Outer Supports "C" to "B" Span

Inner TF coil mtg. brkts.

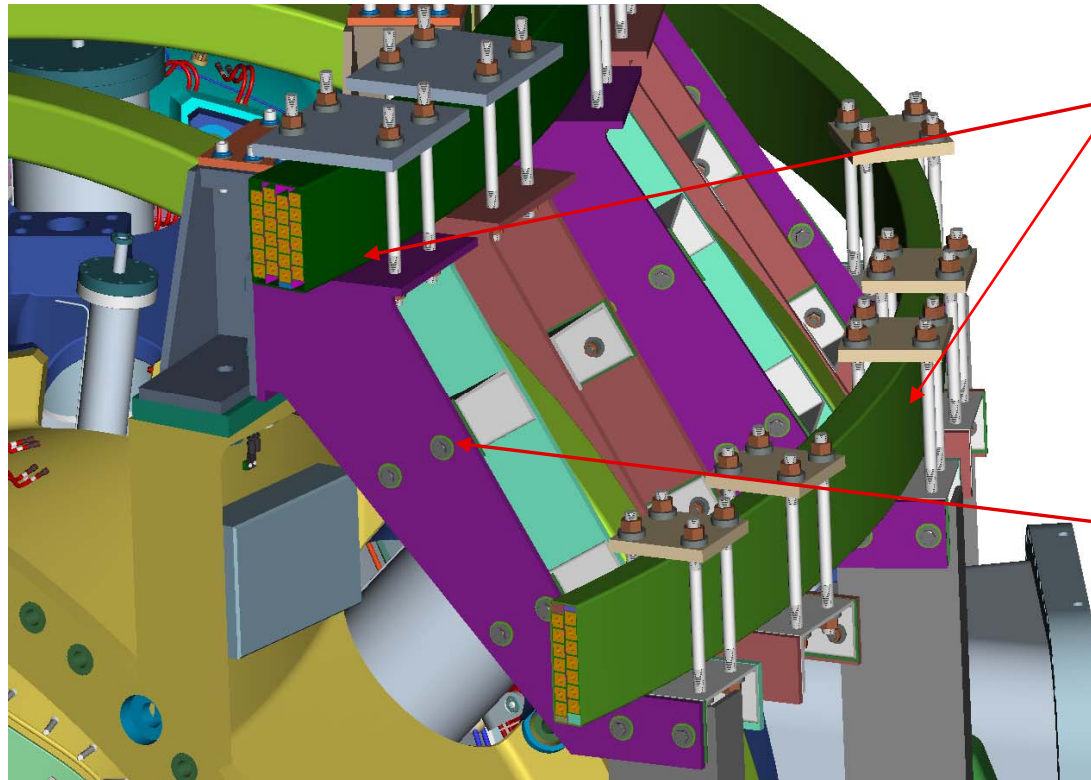


Outer TF Coil mtg. brkts.



PF4 Coil Mtg. off inner TF brkts.

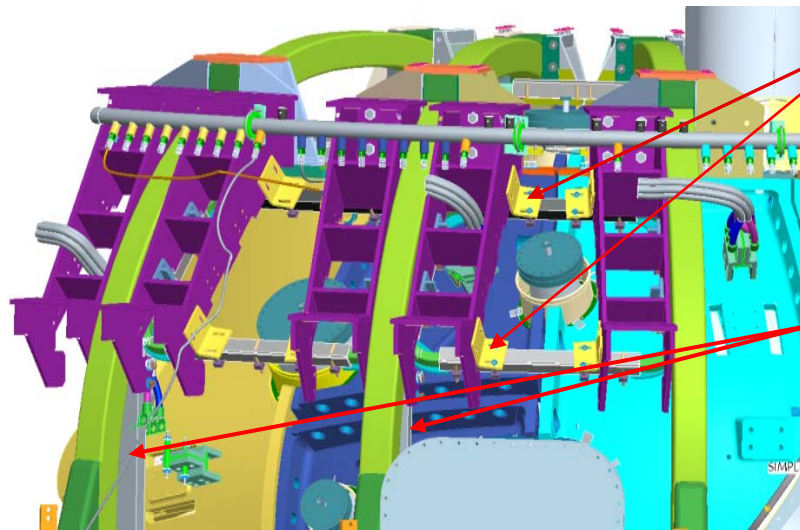
F. Dahlgren -SC Project Review of NCSX, April 8-10, 2008



PF5&6 are shimmed & clamped. Brackets are cantilevered off the outer TF bracket assembly.

All bolted Joints on bracket bracing are now welded.

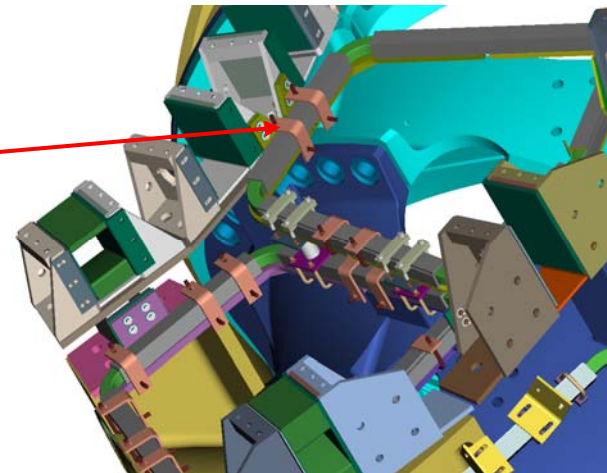
PF Coils are shimmed & clamped to the support brackets



Trim coils mount to PF5 &6 cantilevered bracket assemblies.

Vertical channels provide additional support between the top and bottom brackets.

Inbd. Trim coils mount to TF-bracket assemblies.



Trim Coils are shimmed & clamped to the support brackets

PF-TF Coil Supports -Cost estimate breakdown

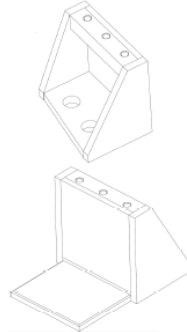


NCSX Coil Support Structure – 1501/1550 Re-baseline estimate – Rev.K 2 April 2008

1. Inner TF support Structure

1a. Supp't brkts. (72 req'd.)

Cutting & machining	6.0 hrs x \$92.00 = \$552.00
Weld prep & weld	2.2 hrs x 76.00 = 167.20
Clean-up de-scale de-burr	0.5 hrs x 76.00 = 38.00
Mat'l.: 304ss plate	120 lbs. x 6.90 = 828.00



*1b. G11-CR Mtg. blocks (36 req'd.)

Cutting & machining (2 pcs.)	2.5 hrs x \$92.00 = \$230.00
Epoxy adhesive bond to coil	0.5 hrs x \$75.00 = 37.50
Mat'l.: G11-CR plate \$48.00 per pc.	2 pcs. x \$48.00 = 96.00

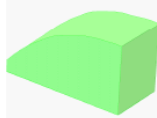
*1c. G11-CR Side Wedge Shims (4 pcs. Req'd per set x 36 sets)

Cutting & Machining wedges	3.0 hrs. x \$92.00 = \$276.00
Mat'l.: G11-CR plate \$42.00 per pr.	2 pcs. x 42.00 = 84.00
Teflon pads 1/8" thk.	2 pcs x 27.00 = 54.00



**1d. Inconel Hardware (36 sets Req'd.)

(4) 1-8 N.C. x 2.5" Hex Head Bolts	4 pcs. x \$50.40 = \$201.60
(4) 1" Flat Washer – Heavy Series	4 pcs. x 3.65 = 14.60
(4) 1" Lock Washer	4 pcs. x 2.95 = 11.80
(6) ½ -13 N.C. Hex Head Bolts	6 pcs. x 19.80 = 118.80
(6) ½" Flat Washers – Heavy Series	6 pcs. x 2.65 = 15.90
(6) ½" Split Lock Washer	6 pcs. x 2.10 = 12.50



1e. T.F. Bridge Clamp (36 Req'd)

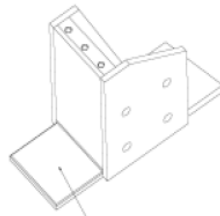
Cutting & machining	3.0 hrs x \$92.00 = \$276.00
Mat'l.: 304 ss plate	36.0lbs x 6.90 = 248.40

*1f. PFTE coated G11-CR wedge assemblies (72 Req'd.)

Cutting & machining	2 pcs. x 3.0 hrs x 92.00 = 550.00
Teflon coating	2 pcs @ \$40.00/pc. = 80.00

1g Lateral TF pre-load (36 req'd.)

TF preload ass'y	1,740 per ass'y.= 1,740.00
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2. Outer TF support Structure

2a. Supp't brkts. (72 req'd.)

Cutting & machining	7.5 hrs x \$92.00 = \$690.00
Weld prep & weld	2.5 hrs x 76.00 = 190.00
Clean-up de-scale de-burr	0.5 hrs x 76.00 = 38.00
Mat'l.: 304 ss plate plate	165 lbs. x 6.90 = 1138.00

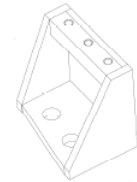
*2b. G11-CR Mtg. blocks (36 req'd.)

Cutting & machining (2 pcs.)	2.5 hrs x \$92.00 = \$230.00
Epoxy adhesive bond to coil	0.5 hrs x \$75.00 = 37.50
Mat'l.: G11-CR plate \$48.00 per pc.	2 pcs. x \$48.00 = 96.00

Outer TF support Structure (con't.)

*2c. G11-CR Side Wedge Shims (4 pcs. Req'd per set x 36 sets)

Cutting & Machining wedges	3.0 hrs. x \$92.00 = \$276.00
Mat'l.: G11-CR plate \$42.00 per pr.	2 pcs. x 42.00 = 84.00
Teflon pads 1/8" thk	2 pcs x 27.00 = 54.00



**2d. Inconel Hardware (36 sets Req'd.)

(4) 1-8 N.C. x 2.5" Hex Head Bolts	4 pcs. x \$50.40 = \$201.60
(4) 1" Flat Washer – Heavy Series	4 pcs. x 3.65 = 14.60
(4) 1" Lock Washer	4 pcs. x 2.95 = 11.80
(6) ½ -13 N.C. Hex Head Bolts	6 pcs. x 19.80 = 118.80
(6) ½" Flat Washers – Heavy Series	6 pcs. x 2.65 = 15.90
(6) ½" Split Lock Washer	6 pcs. x 2.10 = 12.50

2e. T.F. Bridge Clamp & pre-load ass'y. (36 Req'd)

Cutting & machining	3.0 hrs x \$92.00 = \$276.00
Mat'l.: 304 ss plate plate	36.0lbs x 6.90 = 248.40
Lateral TF preload ass'y (36 req'd.)	1,740 per ass'y.= 1,740.00

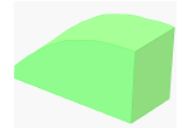


*2f. PFTE coated G11-CR wedge assemblies (72 Req'd.)

Cutting & machining	2 pcs. x 3.0 hrs x 92.00 = 550.00
Teflon coating	2 pcs @ \$40.00/pc. = 80.00

1g Lateral TF pre-load (36 req'd.)

TF preload ass'y	1,740 per ass'y.= 1,740.00
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3. PF5/PF6 Support Brkt. Ass'y. (66 Req'd.)

3.a Bracket Ass'y (66 Req'd.)

Cutting & Machining	12.0 hrs x \$92.00 = \$1104.00
Weld prep & weld	6.5 hrs x 76.00 = 494.00
Clean-up de-scale de-burr	1.5 hrs x 76.00 = 114.00
Mat'l.: 304 ss plate plate	120.0lbs x 6.90 = 828.20

3b. P.F. 5 Bridge Clamps (66 Req'd)

Cutting & machining	3.0 hrs x \$92.00 = \$276.00
Mat'l.: 304 ss plate plate	36.0lbs x 6.90 = 248.40

3c. P.F. 6 Bridge Clamps (66 Req'd)

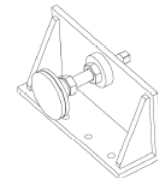
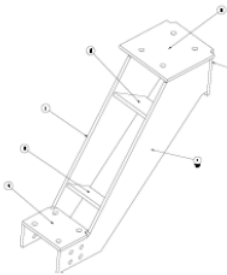
Cutting & machining	3.0 hrs x \$92.00 = \$276.00
Mat'l.: 304 ss plate plate	36.0lbs x 6.90 = 248.40

**3d. Inconel Hardware (66 sets Req'd.)

(4) ¼-10 N.C. x 8.5" Hex Head Bolts	4 pcs. x \$ 68.90 = \$275.60
(4) ¼-10 N.C. x 9.5" Hex Head Bolts	4 pcs. x 73.90 = 295.60
(4) ¼-10 N.C. Hex Nuts	4 pcs. x 24.80 = 99.20
(8) 1" Flat Washer – Heavy Series	8 pcs. x 3.65 = 29.20
(8) 1" Lock Washer	8 pcs. x 2.95 = 23.80

3e Positioning Brkt. Ass'y. (21 Req'd)

Cutting & Machining	8.0 hrs x \$92.00 = \$ 736.00
Weld prep & weld	2.5 hrs x 76.00 = 190.00
Clean-up de-scale de-burr	1.5 hrs x 76.00 = 114.00
Mat'l.: 304 ss plate plate	105.0lbs x 6.90 = 724.50



PF-TF Coil Supports -Cost estimate breakdown -con't.



4. PF5/PF6 Support Frame Ass'y Long Span (6 Ass'y. Req'd)

4a. Vertical channels (For 3 -Req'd. per ass'y)

Cutting & Machining	2.0 hrs x \$92.00 = \$184.00
Clean-up de-scale de-burr	0.8 hrs x 76.00 = 60.80
Mat'l: 304 ss channel	44.0lbs x 8.50 = 374.00

**4b. Inconel Mtg. Hardware (6 sets of 4 per ass'y)

(4) 1/2 -13 N.C. Hex Head Bolts	4 pcs. x 24.50 = 98.00
(4) 1/2 -13 N.C. Hex Nuts	4 pcs. x 16.80 = 67.20
(4) 1/2" Flat Washers - Heavy Series	4 pcs. x 2.65 = 10.60
(4) 1/2" Split Lock Washer	4 pcs. x 2.10 = 8.40



5. PF5/PF6 Support Frame Ass'y Short Span (6 Ass'y. Req'd)

5a. Vertical channels (For 3 -Req'd. per ass'y)

Cutting & Machining	2.0 hrs x \$92.00 = \$184.00
Clean-up de-scale de-burr	0.8 hrs x 76.00 = 60.80
Mat'l: 304 ss channel	44.0lbs x 8.50 = 374.00

**5b. Inconel Mtg. Hardware (3 sets of 4 per ass'y)

(4) 1/2 -13 N.C. Hex Head Bolts	4 pcs. x 24.50 = 98.00
(4) 1/2 -13 N.C. Hex Nuts	4 pcs. x 16.80 = 67.20
(4) 1/2" Flat Washers - Heavy Series	4 pcs. x 2.65 = 10.60
(4) 1/2" Split Lock Washer	4 pcs. x 2.10 = 8.40



Winco purchased pt.	\$30.60
Solon Washer	\$7.95
10 hr x 81	= \$810
4 hr x 81	= \$360
6 hr x 81	= \$540
Total:	\$ 1,748.56

Supplemental parts Inner & Outer TF Lateral Pre-load: \$125,876

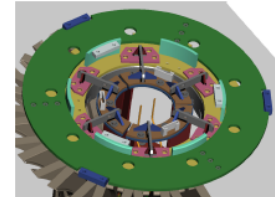
6. TF Pre-load Ring & PF4 Support Brkts (2 rings, 2 sets of brkts.)

6a. Base Ring

Castings	355 lbs x \$35.00 = \$12,425.00
Machining	120 hrs x 92.00 = 11,040.00

6b. PF4 Brkts Inco plate weldments - (6 Top & 6 Bottom)

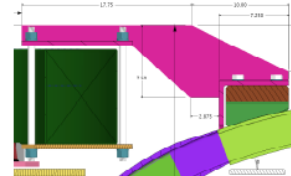
(6) Cutting & Machining	2.5 hrs x 6 x \$92.00 = \$1380.00
(6) Weld prep & weld	1.5 hrs x 6 x 76.00 = 684.00
(6) Clean-up de-scale de-burr	3.0 hrs x 6 x 76.00 = 228.00
(6) Mat'l: Inconel 625 plate	41.0lbs x 28.50 = 1168.50



7. C.S. Coil mtg. brkts. (2x=12 brkts total)

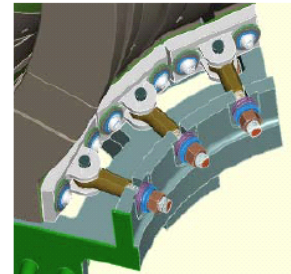
7a. Inconel Suppt't brackets (2 sets Req'd - 6 Top & 6 Bottom)

(6) Cutting & Machining	6.5 hrs x 6 x \$92.00 = \$3588.00
(6) Weld prep & weld	2.5 hrs x 6 x 76.00 = 1140.00
(6) Clean-up de-scale de-burr	3.0 hrs x 6 x 76.00 = 228.00
(6) Mat'l: Inconel 625 plate	67.0lbs x 6 x 28.50 = 11,336.40



**7b. Inconel Mtg. Hardware (6 sets of 4 per ass'y)

(4) 1/2 -13 N.C. Hex Head Bolts	4 pcs. x 24.50 = 98.00
(4) 1/2 -13 N.C. Hex Nuts	4 pcs. x 16.80 = 67.20
(4) 1/2" Flat Washers - Heavy Series	4 pcs. x 2.65 = 10.60
(4) 1/2" Split Lock Washer	4 pcs. x 2.10 = 8.40



8. T.F. Pre-load clamp Assemblies

8a. Stellite casting (36 Required) \$350.00 x 36 = 12,600.00

(36) Inco 3/4 -10NC Pivot Bolt. 1.25 grip 41.50 x 36 =	1,494.00
(36) Inco 3/4 -10NC Hex Nut 24.80 x 36 =	892.80
(72) Inco 1/2 -13NC Hex Head Bolt 16.80 x 72 =	1,209.60
(72) Inco 1/2" Flat Washers 2.65 x 72 =	190.80
(72) G11-CR Washer 1.40 x 72 =	100.80
(72) G11-CR Sleeve 2.50 x 72 =	180.00
(36) Inco 3/4 -10NC" Jack Nut 28.50 x 36 =	1,026.00
(36) Inco 3/4" Swivel Eye-Bolt 51.50 x 36 =	1,854.00
(36) G11-CR 1/4" thk. Insul. Pad 18.50 x 36 =	666.00



PF-TF Coil Supports -Cost estimate breakdown -con't.



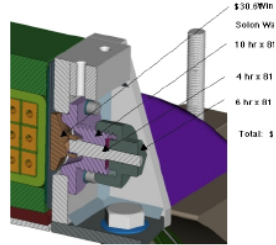
9. P.F. 4 Bridge clamps (12 req'd.)

- 9a. (1) C & M Plates 6" x 6" x 1/4".....4.5 hrs x 1 x \$92.00 = 414.00
- 9b. Clean-up de-scale de-burr1.5 hrs x 76.00 = 114.00
- **9c. Inconel Hardware
 - (4) 1/2 -13 N.C. Hex Head Bolts4 pcs. x 24.50 = 98.00
 - (4) 1/2 -13 N.C. Hex Nuts4 pcs. x 16.80 = 67.20
 - (4) 1/2" Flat Washers – Heavy Series4 pcs. x 2.65 = 10.60
 - (4) 1/2" Split Lock Washer4 pcs. x 2.10 = 8.40
- *9d. (1) G11-CR 1/4" thk. Insul. Pad18.50 = 18.50
- *9e. (2) Teflon pads2 pcs. x 27.00 = 54.00
- 9f. 6 x 6 x 1/4" thick Inconel601 plate.....27.0lbs x 22.50 = 607.50



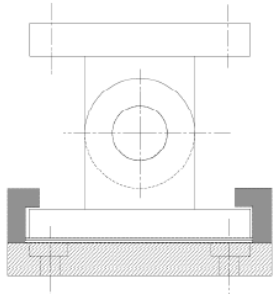
10. Inner & outer spacer blocks MCWF-TF supp't brkts (24 Req'd.)

- 10a. C & M blocks.....10hrs x 92.00 = 920.00
- 10b. Clean-up, de-scale & de-burr.....1.5 hrs x 92.00 = 138.00
- **10c. (4) Inco 1/4 -10NC Hex Bolt4.25 grip 64.90 x 4 = 259.60
- **10d. (4) Inco 1/4" Flat Washers3.40 x 4 = 13.60
- 10e. 304 ss 6" x 6" x 3" thick.....32lbs ea. x \$6.90 = 220.00
- 10f. Lateral TF preload ass'y.....1,740 per ass'y = 1,740.00



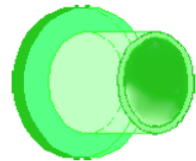
11. Machine/base support Interface (6 Req'd.)

- 11a. C & M plates(11 parts) 80 hrs x 92.00 = 7,360.00
- 11b. Weld Clevises & side plates16 hrs x 75.00 = 1,200.00
- 11c. Clean-up, de-scale & de-burr.....4 hrs x 92.00 = 368.00
- 11c. Spherical Bearings1 x 2850.00 = 2850.00
- *11e. C & M G11 & Teflon sheets8 hrs x 92.00 = 736.00
- 11f. Inco 625 plates & rnd. Bar.....144 lbs x 28.50 = 4,104.00
- *11g. G11-CR Plate10" x 10" x 1" = 158.00
- *11h. Teflon sheet8" x 8" x .13" = 56.00
- **11i. Inconel Hardware (2 sets Req'd.)
 - (4) 1-8 N.C. x 2.5" Hex Head Bolts4 pcs. x \$50.40 = \$201.60
 - (4) 1" Flat Washer – Heavy Series4 pcs. x 3.65 = 14.60
 - (4) 1" Lock Washer4 pcs. x 2.95 = 11.80



12. Misc. Assembly Hardware

- 12a. G11 bushings TF clamps360 x 2.50 = 900.00
- 12b. G11 washers TF clamps360 x 0.80 = 288.00
- 12c. G11 bushings Frame Assy'168 x 2.50 = 420.00
- 12d. G11 washers PF Clamps168 x 0.80 = 134.40
- 12e. G11 bushings PF Clamps168 x 2.50 = 420.00
- 12f. G11 washers Frame Ass'y168 x 0.80 = 134.40
- 12g. G11 bushings M/B interface24 x 2.50 = 60.00
- 12h. G11 washers M/B interface24 x 0.80 = 19.20
- **12i. Inconel 718 .75 ID B'ville washers.....720 x 12.50 = 9,000.00
- **12j. Inconel 718 1.03 ID B'ville washers...360 x 26.93 = 9,694.80



1. Inner TF Support Structure (36)		
1a	I-C&M432	\$67,651.40
1b		\$13,086.00
1c		\$14,904.00
1d		\$13,507.20
1e	I-C&M108	\$11,906.00
1f		\$45,360.00
1g		\$62,640.00
1h		\$3,600.00
1i		\$4,500.00
2. Outer TF Support Structure (36)		
2a	I-C&M540	\$84,154.00
2b		\$13,086.00
2c		\$14,904.00
2d		\$13,507.00
2e	I-C&M108	\$11,906.00
2f		\$45,360.00
2g		\$62,640.00
2h		\$3,600.00
2i		\$4,500.00
3. PF6 Support Bracket Assembly (66)		
3a	I-C&M504	\$149,107.00
3b	I-C&M108	\$21,828.00
3c	I-C&M108	\$21,828.00
3d		\$47,749.40
3e	I-C&M168	\$25,190.00
3f	I-C&M40	\$7,800.00
4. PF6 Support Frame Assembly \$ Long (6)		
4a	I-C&M12	\$3,712.80
4b		\$8,842.00
5. PF6 Support Frame Assembly \$ Short (3)		
5a	I-C&M12	\$3,712.80
5b		\$4,420.90
6. TF Pre-Load Ring & PF4 Support (2)		
6a.	I-C&M240	\$46,930.00
6b	I-C&M15	\$6,920.00
7. C.S. Coil Mounting Brackets (12)		
7a	I-C&M78	\$32,584.00
7b		\$2,210.40
8. TF Coil Pre-Load Clamp Assemblies (36)		
8a		\$37,054.50
9. PF4 Coil Mounting Clamp (12)		
9a	I-C&M54	\$4,968.00
9b		\$1,368.00
9c		\$2,210.40
9d		\$222.00
9e		\$648.00
9f		\$7,295.00
10. MCWF-TF Mtg. Brkt. Spacer block & shim		
10a I-C&M240		\$22,080.00
10b		\$3,312.00
10c		\$6,230.40
10d		\$326.40
10e		\$21,888.00
11. Machine/Base Support Interface		
11a I-C&M240		\$44,160.00
11b		\$7,200.00
11c		\$2,208.00
11d		\$14,544.00
11e		\$4,416.00
11f		\$14,544.60
11g		\$5,968.00
11h		\$336.00
11i		\$10,368.40
12. Misc. Assembly Hardware		
12a		\$900.00
12b		\$288.00
12c		\$420.00
12d		\$134.40
12e		\$420.00
12f		\$134.40
12g		\$60.00
12h		\$19.20
12i		\$9,000.00
12j		\$9,694.80
subtotal		\$1,106,064.60
50% ss mat'l allowance		\$28,808.00
scrap value		-\$6,680.00
M&S Total		\$1,128,192.60
Insp.,Pkging.,Shipping		\$25,000.00
Total FOB Plainsboro,NJ		\$1,153,192.60



PF-TF Coil Supports -Cost estimate breakdown -con't.



Cost estimates are based primarily on budgetary quotes from prospective vendors:

PASSAIC COUNTY WELDERS, INC. - QUOTE RECEIVED: 2 MAY 2007

QTY		UNIT COST	TOTAL	NET UNIT WEIGHT	TOTAL WEIGHT
6	REQD---PF-6 VERTICAL STIFFENER DWG. SE151-152 REV O.	\$ 1,645.00	\$ 9,870.00	41.1	246.6
12	REQD---PF-6 VERTICAL STIFFENER DWG. SE151-153 REV O.	\$ 1,310.00	\$ 15,720.00	44.0	528.0
6	REQD---PF-6 SUPPORT ARC DWG. SE151-156 REV O.	\$ 2,471.00	\$ 14,826.00	54.4	326.4
12	REQD---PF-6 SUPPORT ARC DWG. SE151-160 REV O.	\$ 3,253.00	\$ 39,036.00	107.5	1,290.0
42	REQD---PF-5 & PF-6 SUPPORT BRACKET DWG. SE151-175 REV O.	\$ 3,204.00	\$ 134,568.00	113.7	4,775.4
72	REQD---COIL REAR LEFT SUPPORT DWG. SE151-177 REV O.	\$ 1,552.00	\$ 111,744.00	46.3	3,333.6
72	REQD---TF COIL FRONT LEFT BRK. DWG. SE151-179 REV O.	\$ 1,424.00	\$ 102,528.00	33.2	2,390.4
		SUB-TOTAL	\$ 428,292.00		12,890.4
	FOB WAYNE,NJ.			ADJUST WT. 72-RH BRKTS.	(792.0)
	THIS ESTIMATE WAS FOR 316L SOLUTION ANNEALED PLATE				12,098.4

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

ESTIMATE FOR COST DELTA FOR INCONEL 601: @22.50/LB \$ 217,771.20
 SHIPPING, PACKAGING & INSPECTION \$ 15,000.00
 TOTAL ADJUSTED COST FOR ITEMS 1 THRU 7 \$ 681,063.20

MY ESTIMATE FOR 7 ITEMS 1A,2A,3A,4A,4B,5A,5B +S,P&I \$ 628,765.00 -5% LOWER

NOTE: QUOTE FOR 7 ITEMS ONLY TF & PF5&6 BRACKETRY
 NO HARDWARE, INSULATORS, PF4 SUPPTS, TF-PRE-LOAD, BASE SUPPORT INTERFACE, ETC.



F. Dahlgren -SC Project Review of NCSX, April 8-10, 2008

