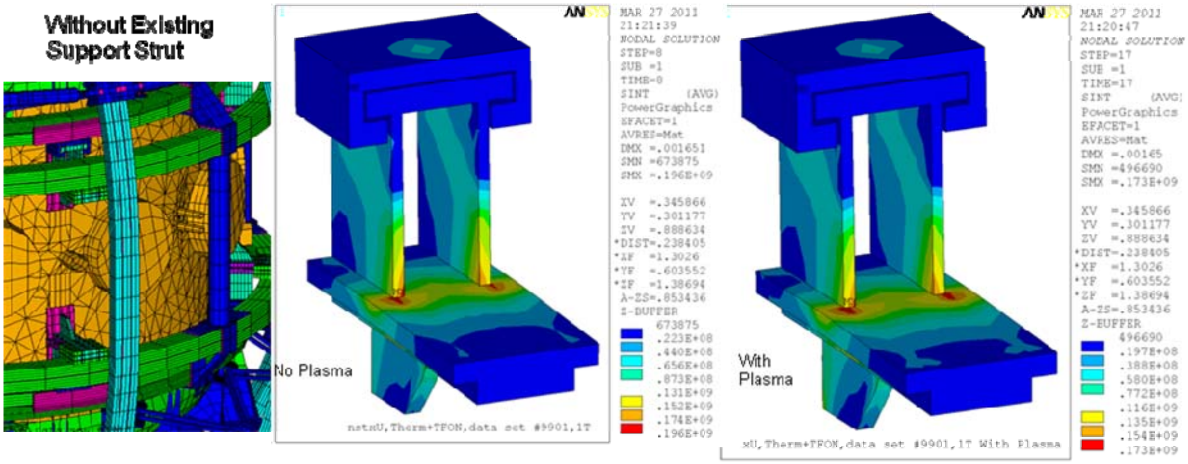


Figure 12.3-1 Existing support bracket without support strut - With and Without plasma

Without the strut, bending stress concentrates at the corners of the gusset plate weld. The global Model [2] was run with and without the support strut.

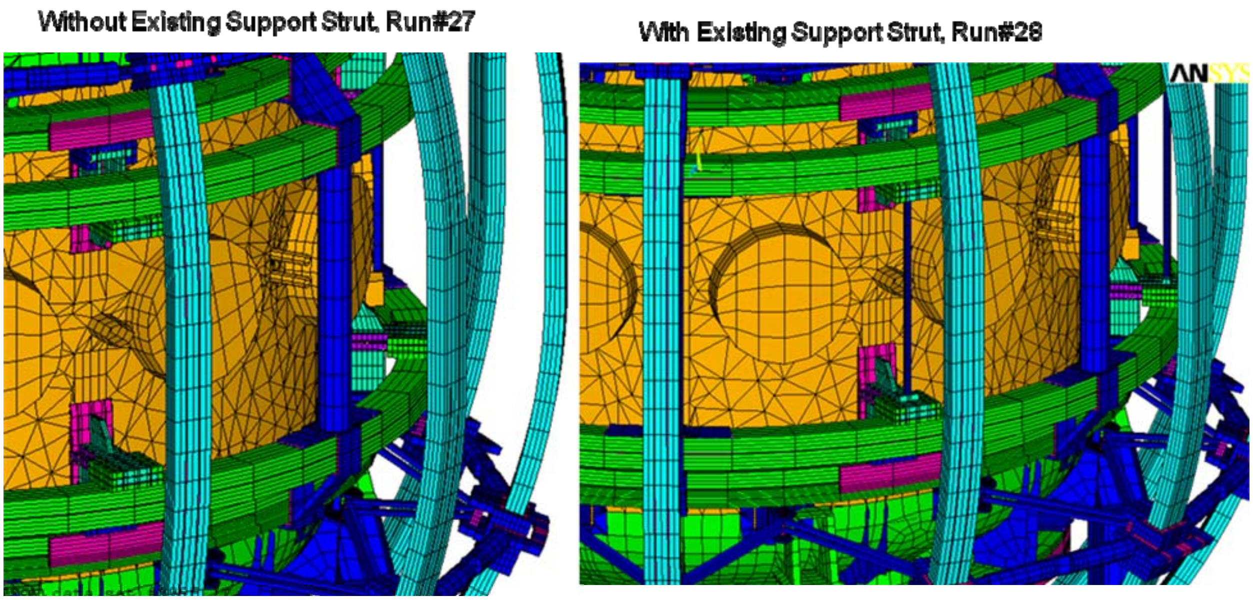


Figure 12.3-2 Models With and Without the Thin Existing Support Strut

Even though the support strut is being retained, the "no strut" case is included here because it is relatively easy to construct stress multipliers for the bending stress in the cantilevered part of the support. This allows exploration of all the identified scenarios, with and without plasmas.

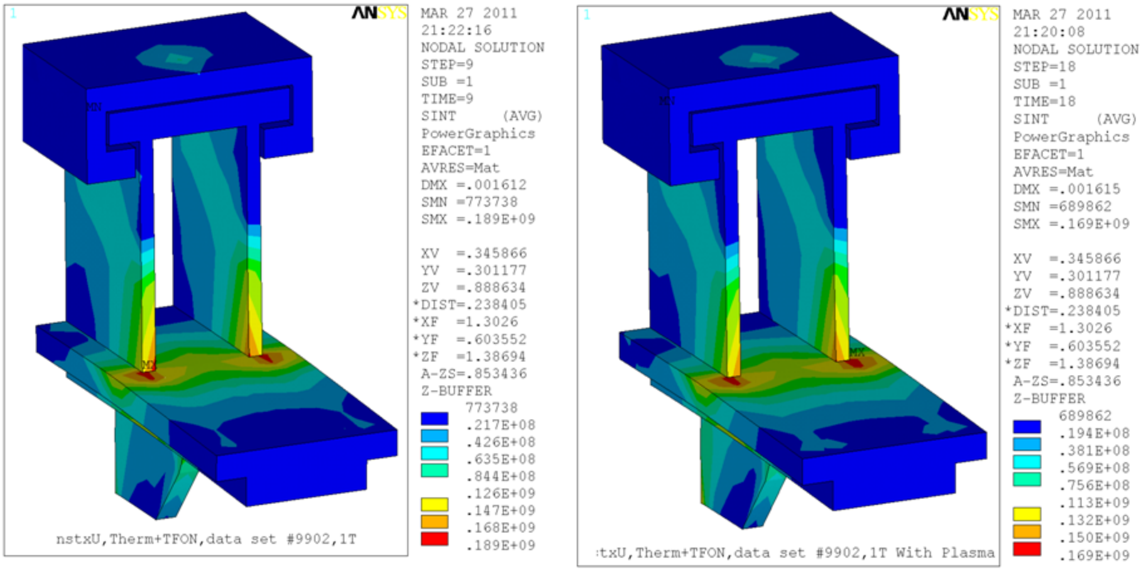


Figure 12.3-3 Existing Support Bracket - No Strut, EQ 02, With and Without Plasma

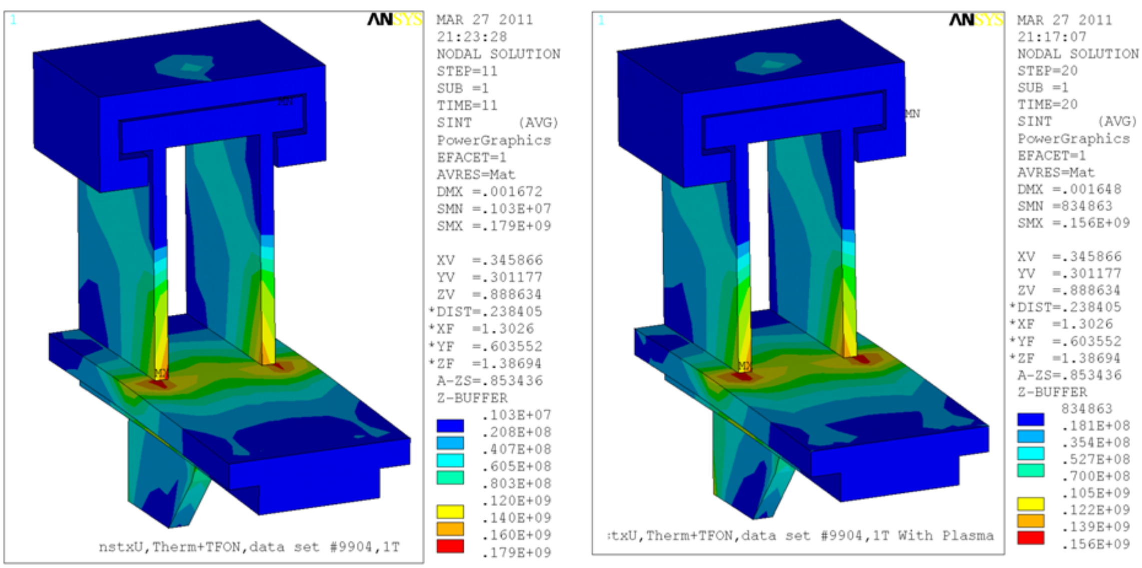


Figure 12.3-4 Existing Support Bracket - No Strut, EQ 04 With and Without Plasma

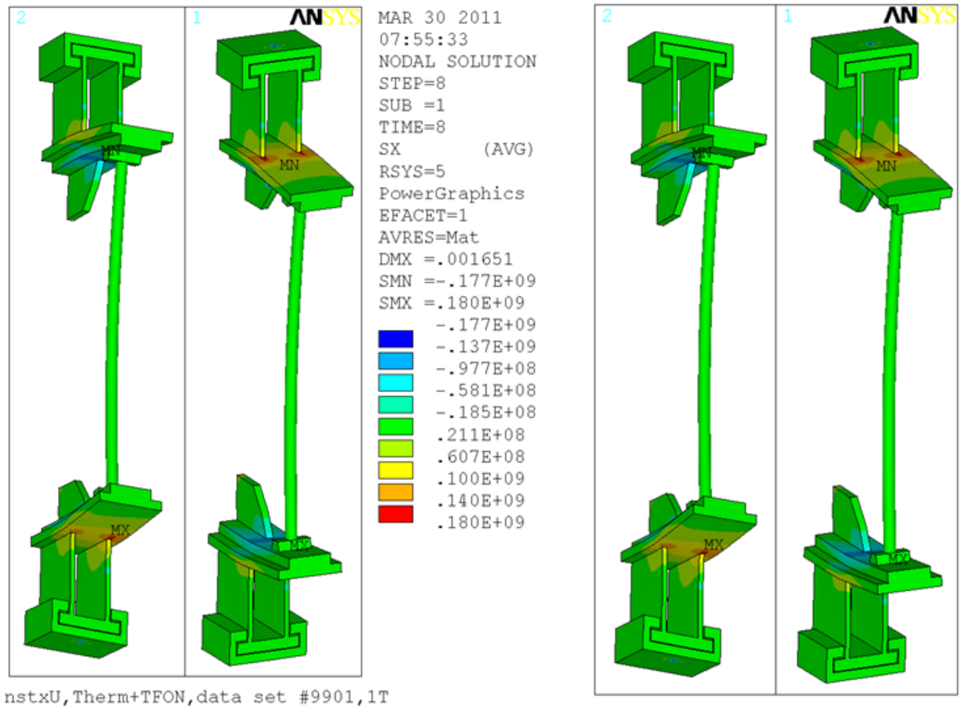


Figure 12.3-5 Existing Support Bracket - With Strut, EQ 01 and EQ 02

It is evident from this plot that the small diameter column does little to resist the cantilever bending of the PF5 support plate. A stiffer section is needed. A heavier column was added in May, 2011 and a model including this has been run and reduces the bending stress on the cantilever section substantially.

Bracket Stress by Influence Coefficients

If the bracket stress is determined primarily by the PF5 loads, the bracket stress can be related to coil current influence coefficients in a way similar to how the coil stresses can be computed. This is not rigorous technically, because the rods/columns will introduce contributions from the lower coils. This section is not included in the DCPS for this reason, but it allows consideration of all 96 scenarios, with and without a plasma.

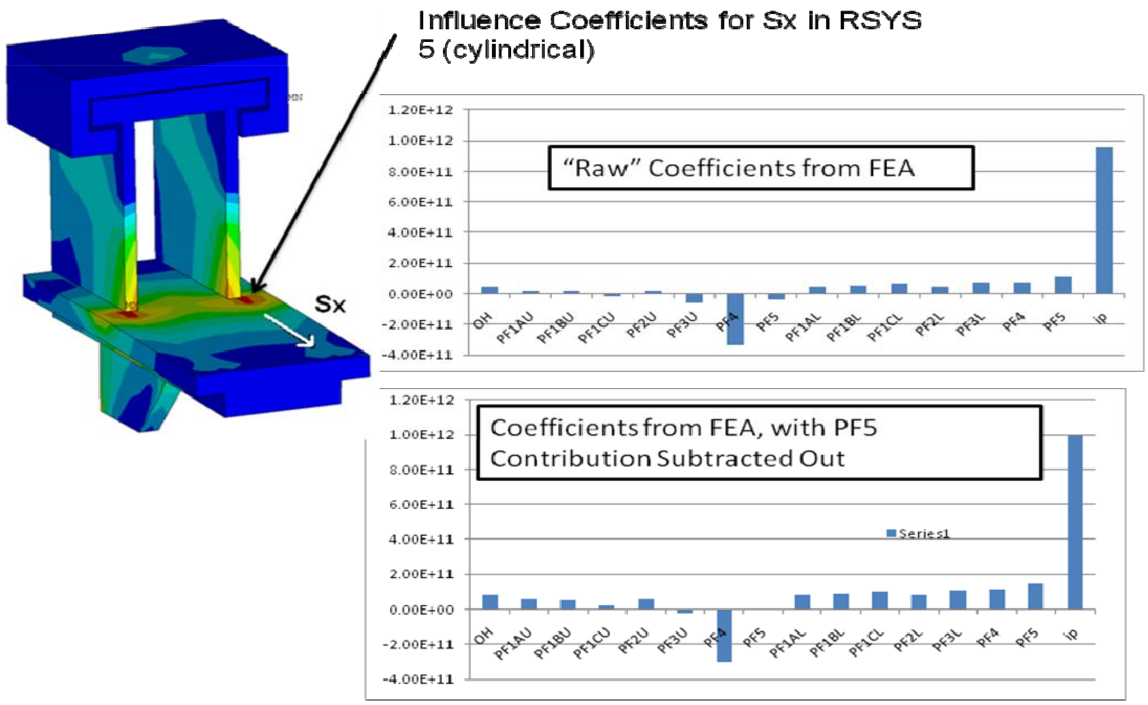


Figure 12.3-6 Influence Coefficients

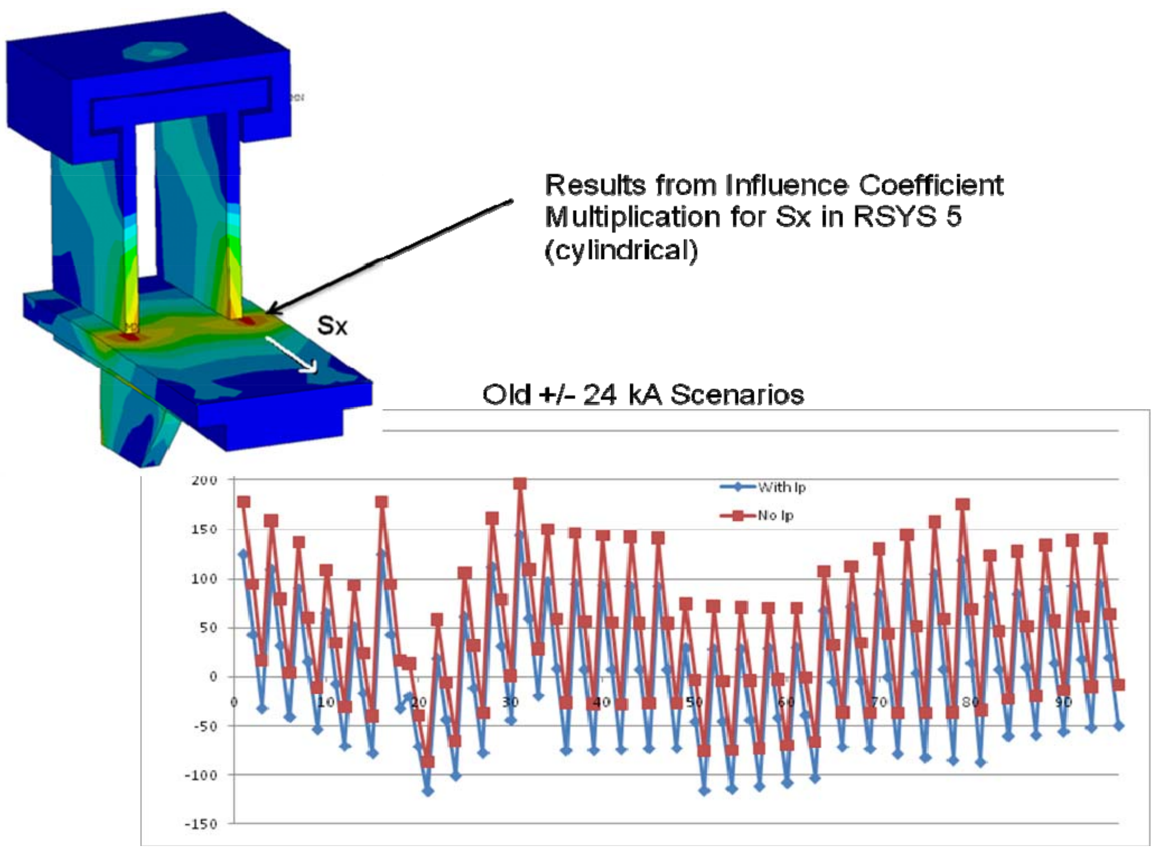


Figure 12.3-7 Influence Coefficient Results

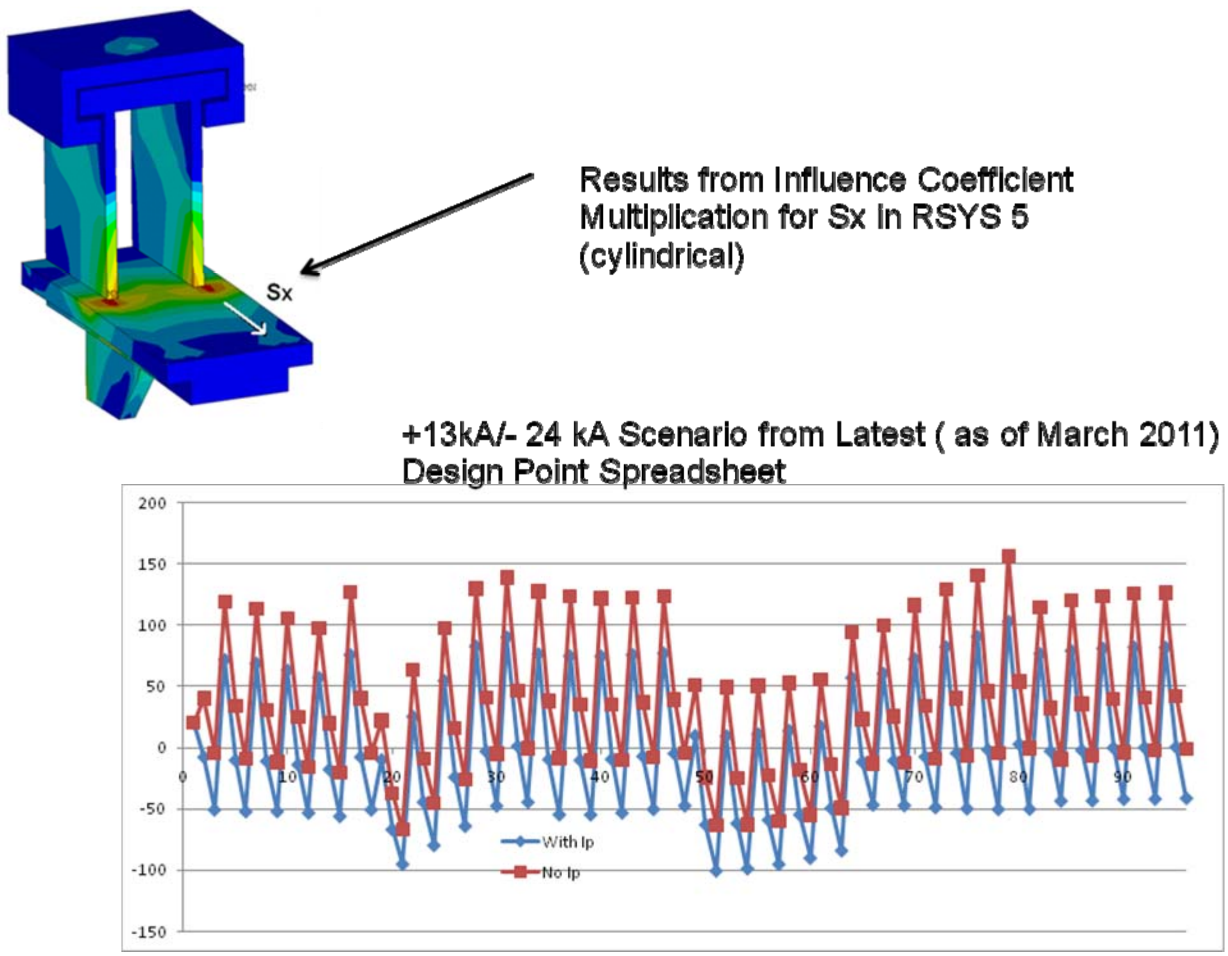


Figure 12.3-8 Influence Coefficient Results

The peak stress in the plate near the weld toe is less than 150 MPa, which is within the static allowable for the bracket material, but is probably a concern with respect to weld fatigue. This is another reason why the existing column/rod should be stiffened.

12.4 Column Stresses from the Global Model

The global model [2] is available to provide column stresses in both the added column and the existing column. Details of the columns had not been finalized at the PDR and FDR. The most recent (December 2011) results are presented in figure 12.4-1 and 2. The peak stress reported in the recent results is 200 MPa (30ksi). FDR results are presented in Figures 12.4-3 and beyond. The conclusion at the FDR was that the existing column/rod is not stiff enough to help the brackets welded to the vessel shell, the stresses in the columns and rods were small (less than 120 MPa in the rod and 30 MPa (in what was analyzed as a 5 inch pipe column at the PDR)). Subsequent to the PDR, the existing columns have been upgraded and as of Dec 2011, all the support points use 3-inch OD pipe with a 0.3 inch wall thickness.

For design of the hardware, Table 6.3-5 shows the max column compressive loads from the design point spreadsheet. The coils are relatively flexible with respect to the 12 support points, so the design point spreadsheet load combinations are adequate to estimate column loads. Find sums of PF4+5U Min (max downward load) and PF4 and 5L max, and divide by 12. This works out to 20,000 lbs on each of the 12 support points. For the PF4 support flanges, the individual coil loads are appropriate to calculate the moment on the column. Take the PF4U min load from the spreadsheet and multiply by the offset between the column CL and the PF4 coil CL, then add it to the 20,000 lbs. The column is centered on the PF5 CL.

This should be conservative because the max PF4 loading will not be at the same time that the max PF4+5 loading occurs. To address the actual combination of PF4 and 5 loading, the global model results for the 96 scenarios is needed.

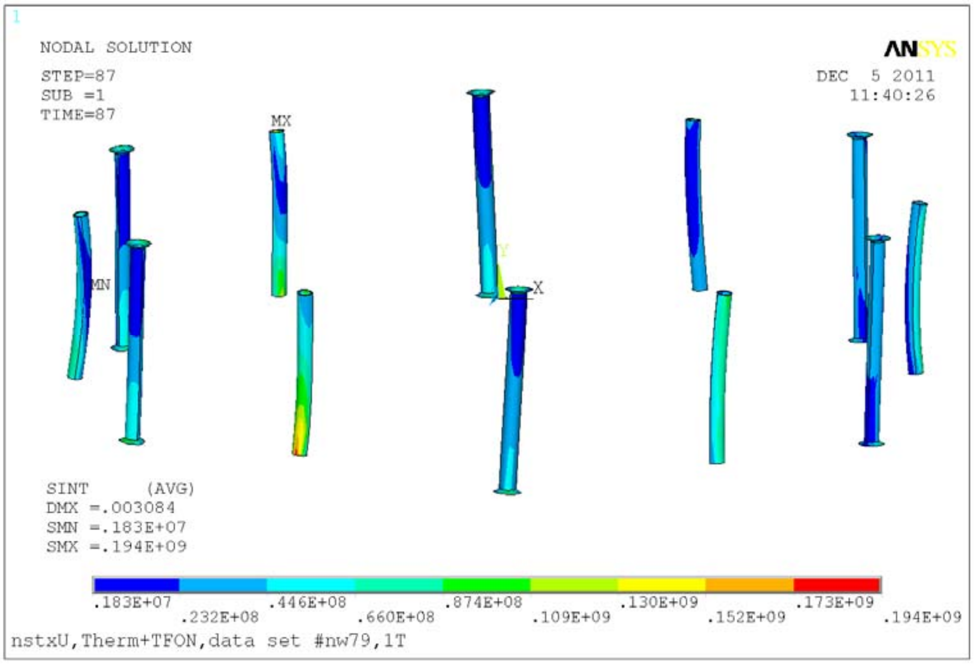


Figure 12.4-1 Column Stress From Global Model with the New Columns and the upgrade of the existing Columns modeled as 3 inch OD 0.3 inch wall thickness Pipe.

EQ 79 is plotted in figure 12.4-1 because it represents a maximum plotted in the Post26 results below.

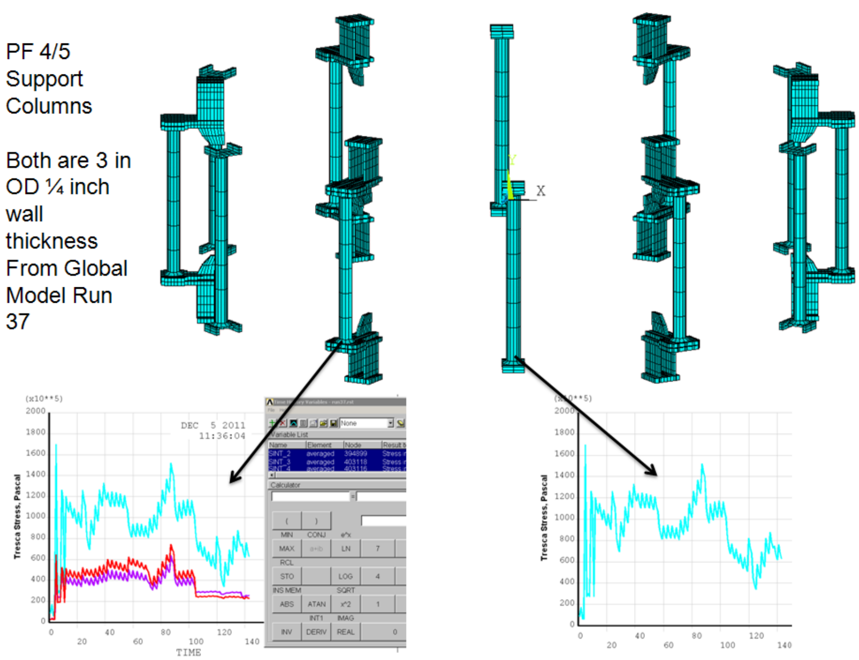


Figure 12.4-2 Column Stress From Global Model with the New Column and the upgrade of the existing column modeled as 3 inch OD 0.3 inch Wall Thickness Pipe

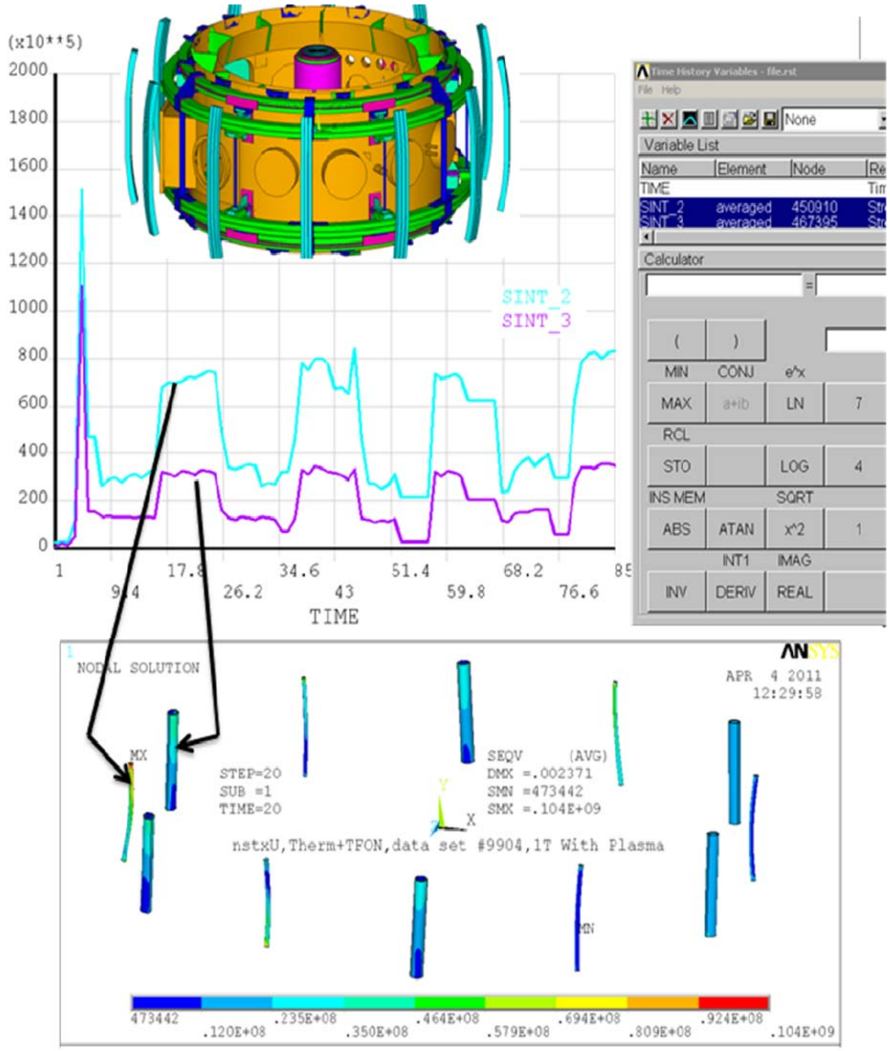


Figure 12.4-3 Column Stress From Global Model (Original Existing thin Column and 5 inch New Column)

In figure 12.4-3, the post 26 results are compared with the contour plots at load step EQ 04. The new mid-span columns are modestly stressed at about 30 MPa for the 5 inch OD column.

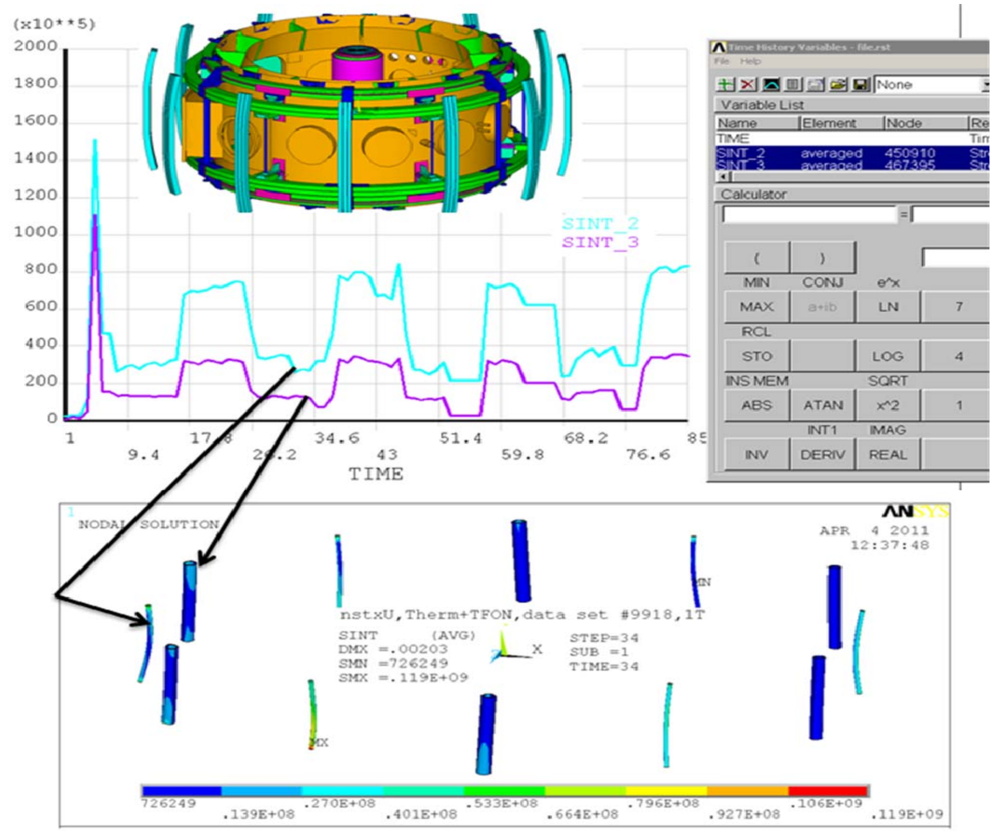
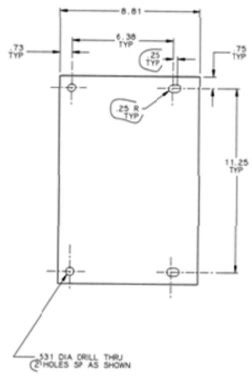


Figure 12.4-4 Column Stress From Global Model (Original Existing thin Column)

In figure 12.4-2, the post 26 results are compared with the contour plots at load step EQ 18

12.5 Coil Clamp Plate Bolting



Clamp Bolts P/A calculations

Clamp Bolts are 1/2 inch. There will be 12 supports resisting the launching load on PF4 or 5 (This assumes up-down symmetry)

Fz(lbf)	PF4U	PF5U	PF4L	PF5L
Min w/o Plasma	-203072	-239929	-78007	-49698
Min w/Plasma	-171095	-150201	-63411	-145201
Min Post-Disrupt	-89212	-203095	-133935	-20016
Min	-203072	-239929	-133935	-145201
Worst Case Min	-415603	-506937	-74506	-181134
Max w/o Plasma	78007	49698	180275	239929
Max w/Plasma	63403	145201	148314	150218
Max Post-Disrupt	133920	20017	89222	203119
Max	133920	145201	180275	239929
Worst Case Max	149049	181133	415804	506937

	Max Launching Load	Load per Bolt(12*4 Bolts)	Stress (Stress Area - .1416)
PF4U	133920	2790	19703.38983
PF5U	145201	3025.020833	21363.14148
PF4L	-133935	2790.3125	19705.59675
PF5L	-145201	3025.020833	21363.14148

	Worst Case Launching Load	Load per Bolt(12*4 Bolts)	Stress (Stress Area - .1416)
PF4U	149049	3105.1875	21929.29025
PF5U	181133	3773.604167	26649.74694
PF4L	74506	1552.208333	10961.92326
PF5L	-181134	3773.625	26649.89407

Figure 12.5-1 PF 4 and 5 Clamp Plate Loads

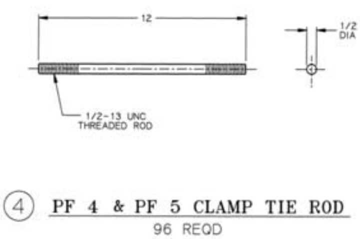
For loading that is up-down symmetric, that is the upper coils are being loaded upward and the lower loads are being loaded downward, then all 12 supports will resist the loads. Then there are four studs per clamp plate and 12 sets of clamp plates. The present FDR design used ¾-inch bolts on the added column clamps, but in this analysis it is assumed that 1/2 inch bolts are used everywhere.

Max Tensile Loads from Design Point

Fz(lbf)	PF4U	PF5U	PF5L	PF4L
Min	-203072	-239929	-145201	-133935
Worst Case Min	-415803	-506937	-181134	-74506
Max	133920	145201	239929	180275
Worst Case Max	149049	181133	506937	415804

Tension Loads on Each Stud Stud

PF4U	PF5U	PF5L	PF4L
		-3025.02	-2790.31
		-3773.63	-1552.21
2790	3025.021		
3105.188	3773.604		



ASTM A193 B8M Class 2

Bold Dia in	Stress Area in^2	Tensile ksi	Yield ksi	Preload .75 Yield	Preload Lbs	Torque .2*F*D in-lbs	Torque .2*F*D ft-lbs	Allowable 2/3 Yield ksi	Allowable Load Load Lbs
0.5	0.1414	110	95	71.25	10074.75	1007.475	83.95625	63.33333	8955.333

Figure 12.5-2 PF 4 and 5 Clamp Plate Bolt Loads

If the loads are not up-down symmetric, for example, if upward loads on the upper coils are not equilibrated by the lower coils, then the clamps welded to the vessel could see larger loads. If 6 support points are assumed, then the loads on the studs for the existing brackets could double from around 4000 lbs to 8000 lbs - still within the allowable for the recommended ASTM A193 B8M Class 2 bolts.

Preloading the bolts will aid in reducing the effect of fatigue. Preloaded clamp bolts will see the preload stress up until the bolted clamp lifts off. If the preload exceeds the applied load, then the bolts only see the preload stress. If the preload is less than the applied load, then the bolts need to be sized and evaluated based on the applied load. By specifying a preload which does not exceed the bolt capacity, and ensuring that the bolt is sized appropriately for the applied loads, guarantees that the bolt stress does not exceed the allowable.

For a static allowable check, the DCPS does not need to include the effect of the preload. To mitigate the potential for fatigue, the preload in the bolts should be specified. The usual practice is to go to 70% yield - this is above the static allowable for which the bolt is qualified - so, it shouldn't unload under the applied load - but for the high strength bolts this may be overkill. The higher preload may stress the copper conductors. It is recommended that the bolts be preloaded based on a 20 ksi yield and some occasional lift-off would be allowed.

12.6 T slot Stress

All supports, except those that are locked (near the leads and 180 degrees opposite) must allow independent radial motion of PF4 and 5. At the PDR, a clamped concept was presented that didn't allow this motion, or, it was expected that the rubber pads would allow the relative motion. A rubber clamped version was run, and for the pad size assumed, the compliance was not good enough to allow the differential motion.

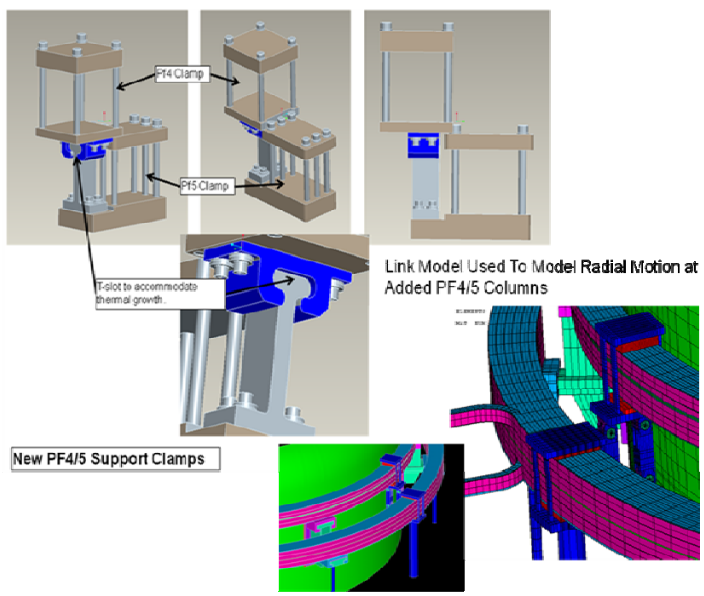


Figure 12.6-1 Dovetail or T slot sliding Block and Link Model Used to Simulate the Radial motion of the sliding block.

The FDR clamp is a design more similar to the existing sliding clamps. This latest design has only been partially analyzed but a link connected design that has the same mechanics has been used to properly model the thermal stresses in the coils. Each of the four tierods that hold PF4 down sees about 4,000 lbs (see Figure 12.5-2 Under Tension Loads on each stud). The T slot shown below (Figure 12.6-2) will see the loads from four studs or 16,000 lbs.

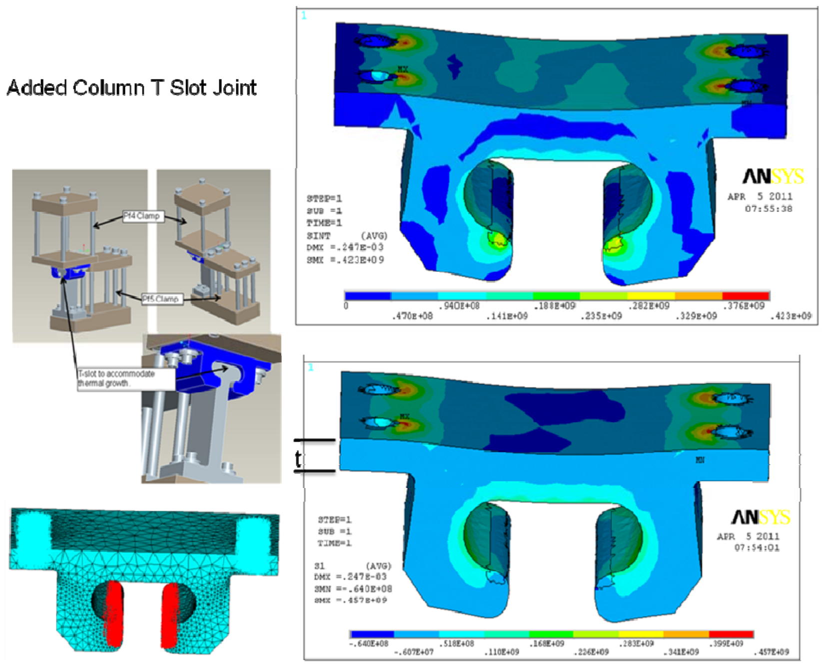


Figure 12.6-2 Dovetail Stress Analysis

Part of the T slot has been analyzed with 16,000 lbs applied. The flange thickness should be increased.

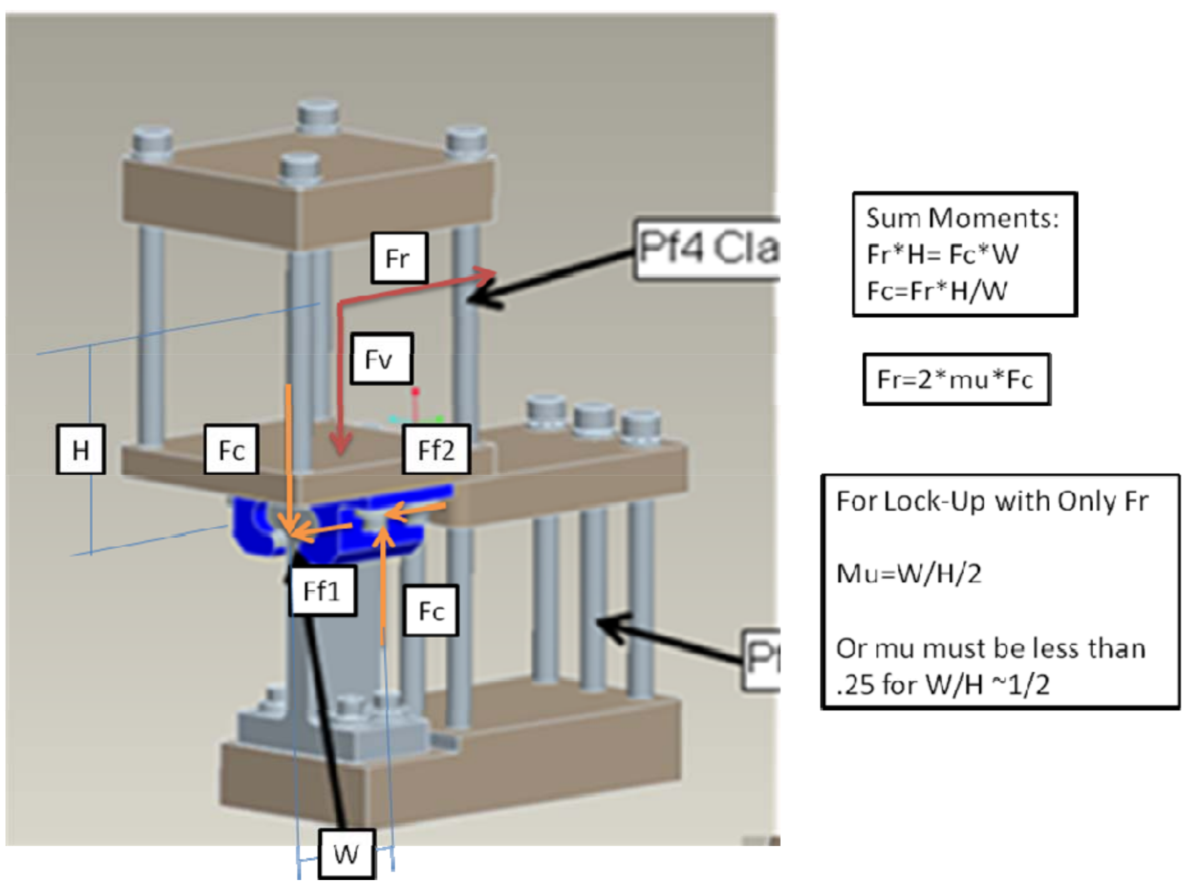


Figure 12.6-3 Mechanics of Self-Locking of the Sliding Support

Fr(lbf)	PF4U	PF4L
Min	-152166	-152181
Max	289472	289442

Fz(lbf)	PF4U	PF4L
Min	-203125	-134053
Max	134052	180293

Table 12.6-1 Forces on PF4 and 5 from the Design Point Spreadsheet

Restraining Force = mu* 203125 +2*mu *h/w*289472
To allow radial growth under Lorentz loads the radial load must be greater than the frictional restraining force, or: 289472 >mu*(203125+2*h/w*289472)
Or mu must be less than 289472/(203125+2*(~2)*289472) = .213
Or mu must be less than .1 for H/W~4
Magna Plate has a Friction Coefficient “as low as .05”.
We are supposed to design to mu +.15 or .2 so, H/w <2

12.7 Vessel Shell Stress

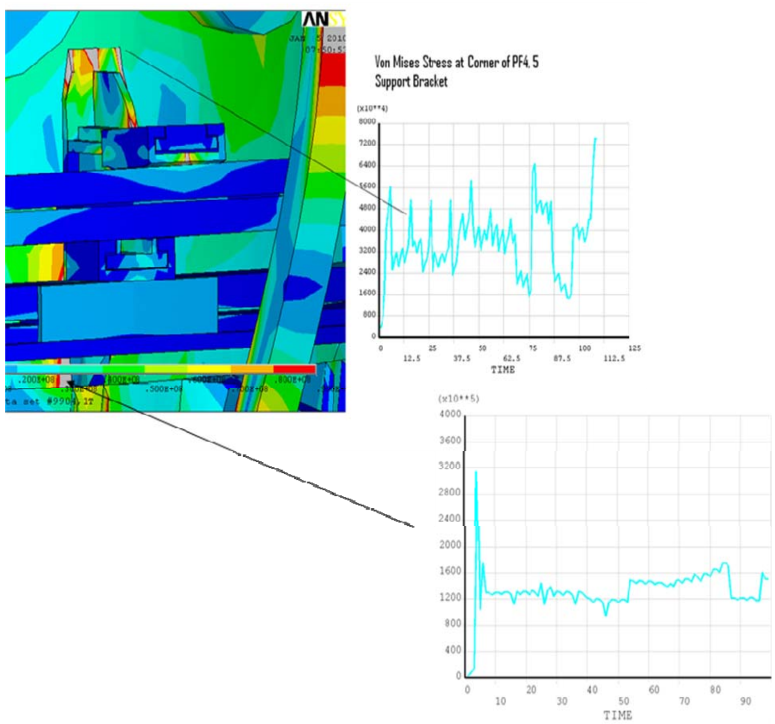


Figure 12.7-1 Vessel Shell Stress Near the Existing PF4/5 Support Brackets

Vessel stresses are 160 MPa at the bottom and 64 MPa at the top (from the Jan 6, 2011, meeting presentation).

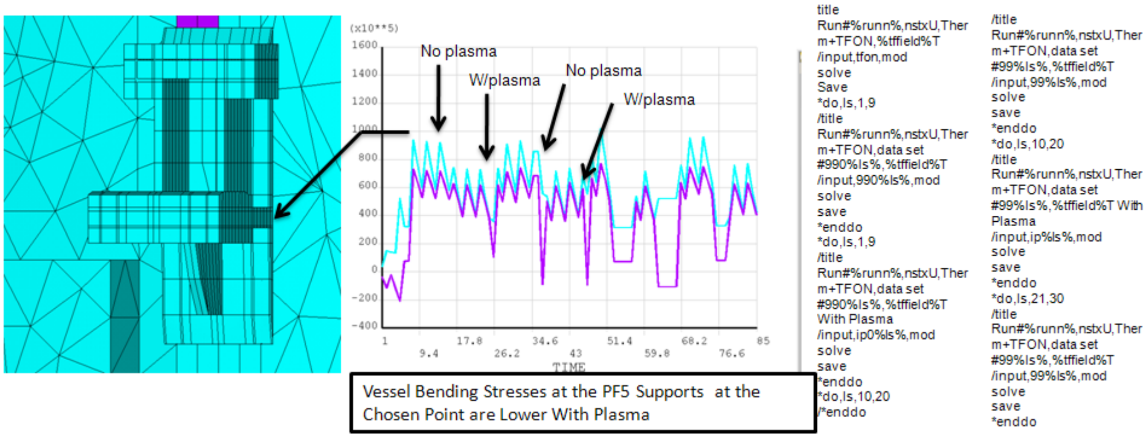


Figure 12.7-2 Vessel Shell Stress Near the Existing PF4/5 Support Brackets

These results show the shell stress slightly higher with no plasma. In the load sequence, first 10 load cases without plasma are analyzed then 10 load cases with plasma are analyzed. The trend in coil tensile stress is the opposite - see Section 9 - but the differences aren't great.

13.0 Bake-Out Thermal Stress

In an early analysis, the existing PF 4 and 5 support hardware was modeled as remaining at RT during bake-out. This produced a sharp gradient between the PF4/5 support bracket and the vessel shell. During a 2010 outage, the bracket was instrumented with thermocouples and the actual bake-out temperature gradient was measured. This was then imposed on the structural model and the stresses were found to be much reduced, particularly in the weld.

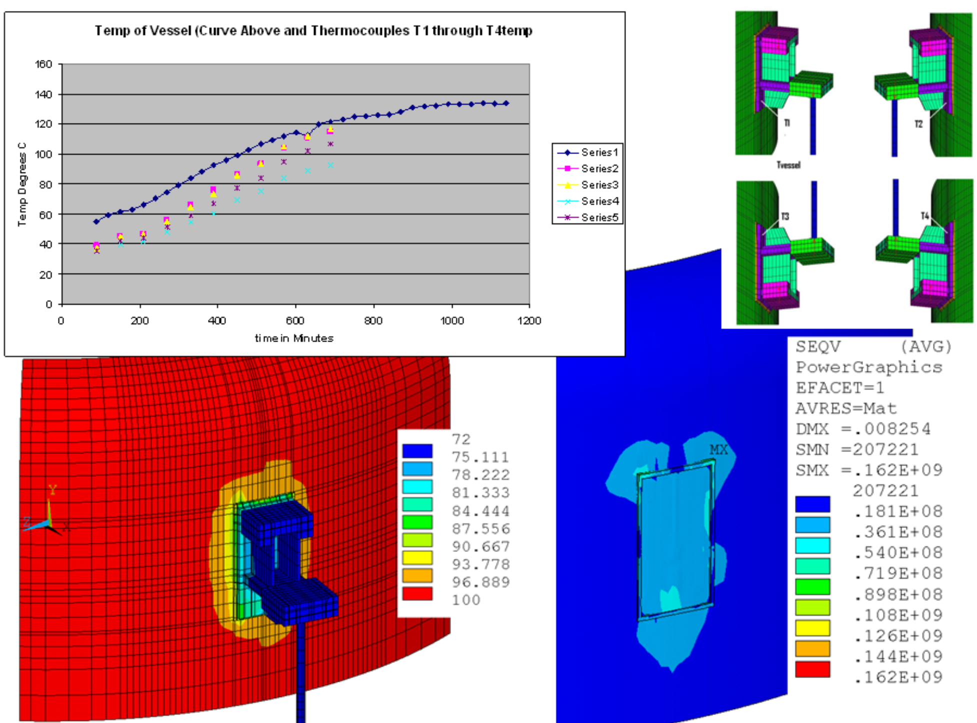


Figure 13.0-1 Vessel Shell Stress Near the Existing PF4/5 Support Brackets During Bake-Out Based on the Measured Bake-Out Temperature Transient

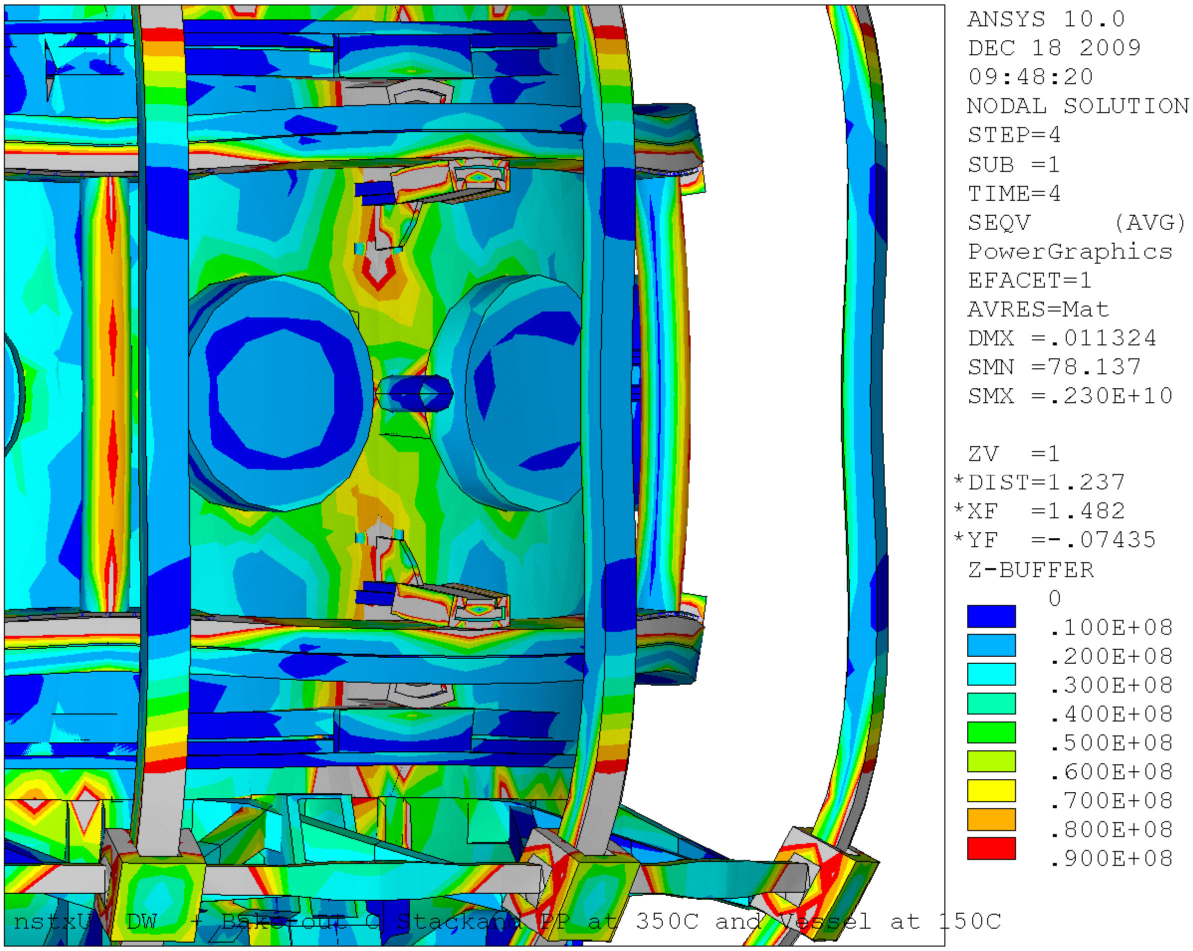


Figure 13.0-2 Vessel Shell Stress Near the Existing PF4/5 Support Brackets During Bake-Out From the Global Model [2] From the Jan 6, 2010 Meeting report.

14.0 Buckling Stability

The new columns were approximated replacing the existing columns with the same pipe section used for the new clamp/column assembly. This is a model that could be meshed quickly. Then, a large displacement solution (ANSYS nlgeo,on) with increasing loading up to 2.6 times the loads for the full current in PF4 and 5 (but no other PF coil or plasma current) was run. The results are linear and the column stresses are 20 ksi at the fully loaded condition. There is no indication of impending collapse under fully loaded conditions - either geometric non-linearity or stresses that would introduce plastic hinges. The analysis was run with increased loading but was terminated prior to the collapse loading.

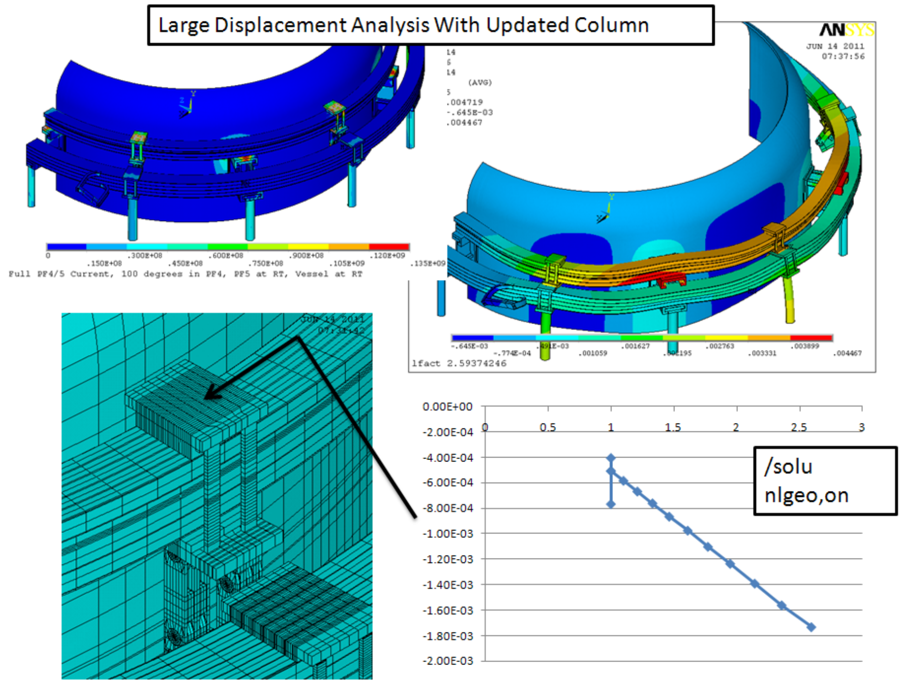


Figure 14.0-1 Large Displacement Loading of the Model to Address The Potential for Elastic or Plastic Collapse

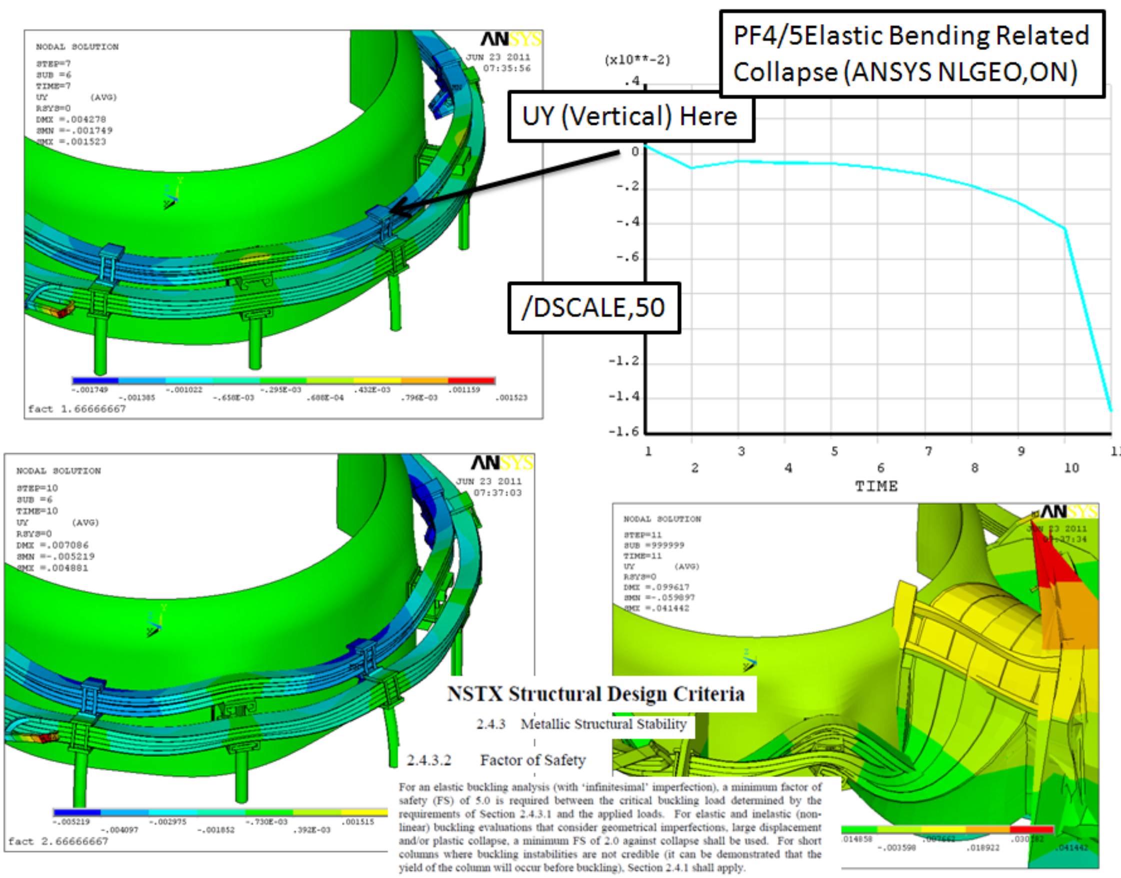


Figure 14.0-2 Large Displacement Loading of the Model Taken to Collapse

The design of the heavier column that will replace the existing column or strut, presented at the May Peer Review, has a shim pack at the mid height of the column. The effect on the stability of the column is a concern. The stack and flanges must be as stiff as the column. It is recommended that the shim pack be put closer to an end that could be a pin end and still be stable.

Regarding coil buckling, this load case does not produce significant compressive hoop stress in either coil. But to get compressive hoop stresses in one or the other coil, there would have to be either reversed currents or a large current in PF4. So, if you have a compressive hoop in one coil, it would have to be coupled with a tension in the other, and since they are connected together via the clamps and radial slides, the tensile loaded coil should stabilize the compressive one.

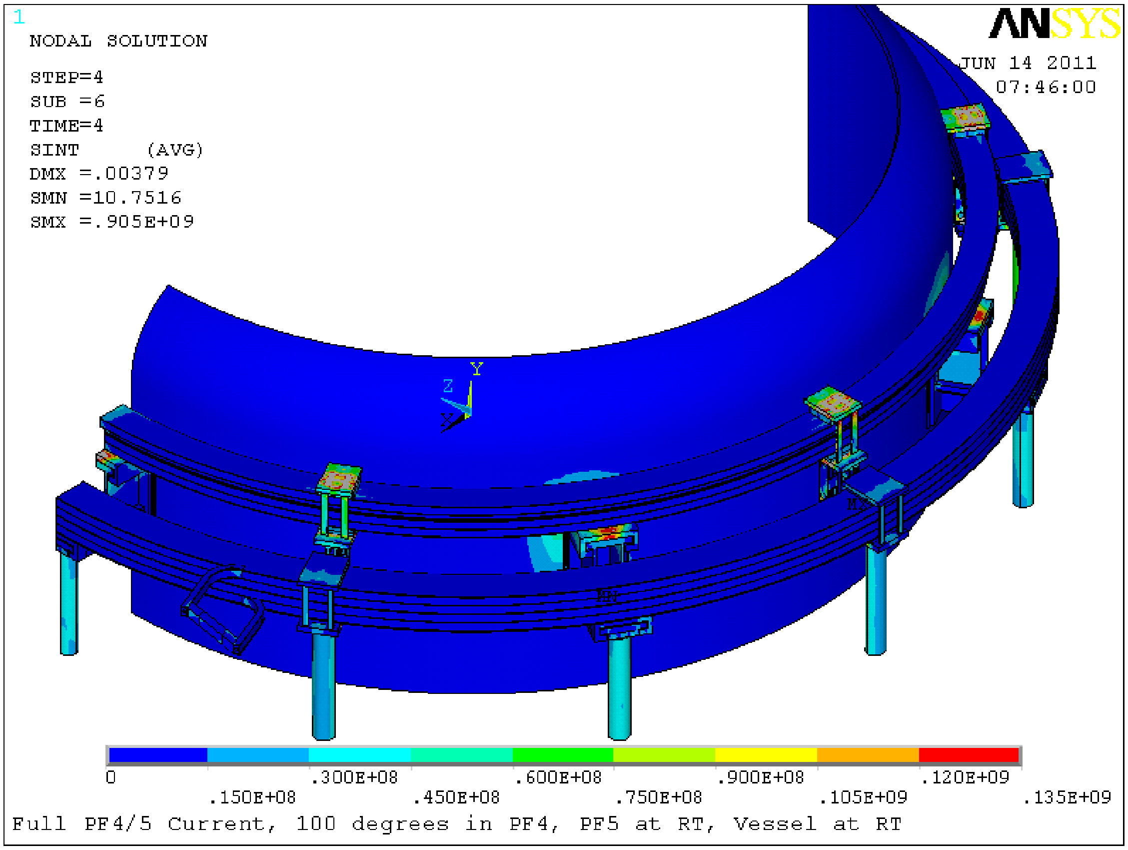


Figure 14.0-3 Initial Loading Tresca Results with a Load Multiplier of 1.0

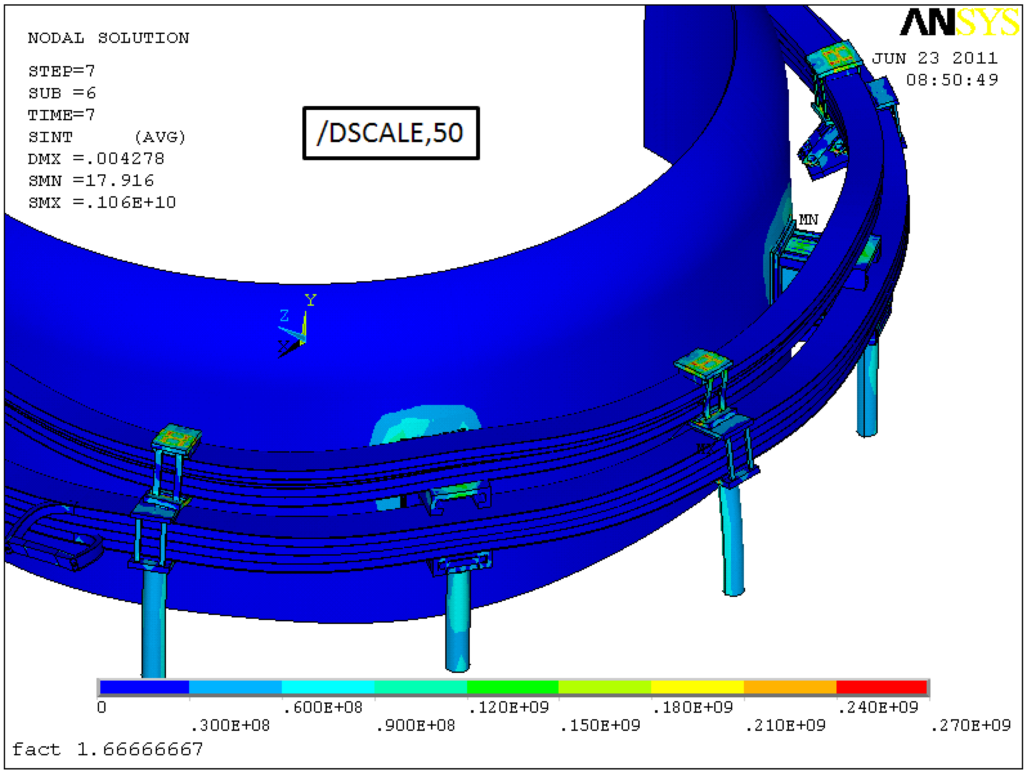


Figure 14.0-4 Initial Loading Tresca Results with a Load Multiplier of 1.7

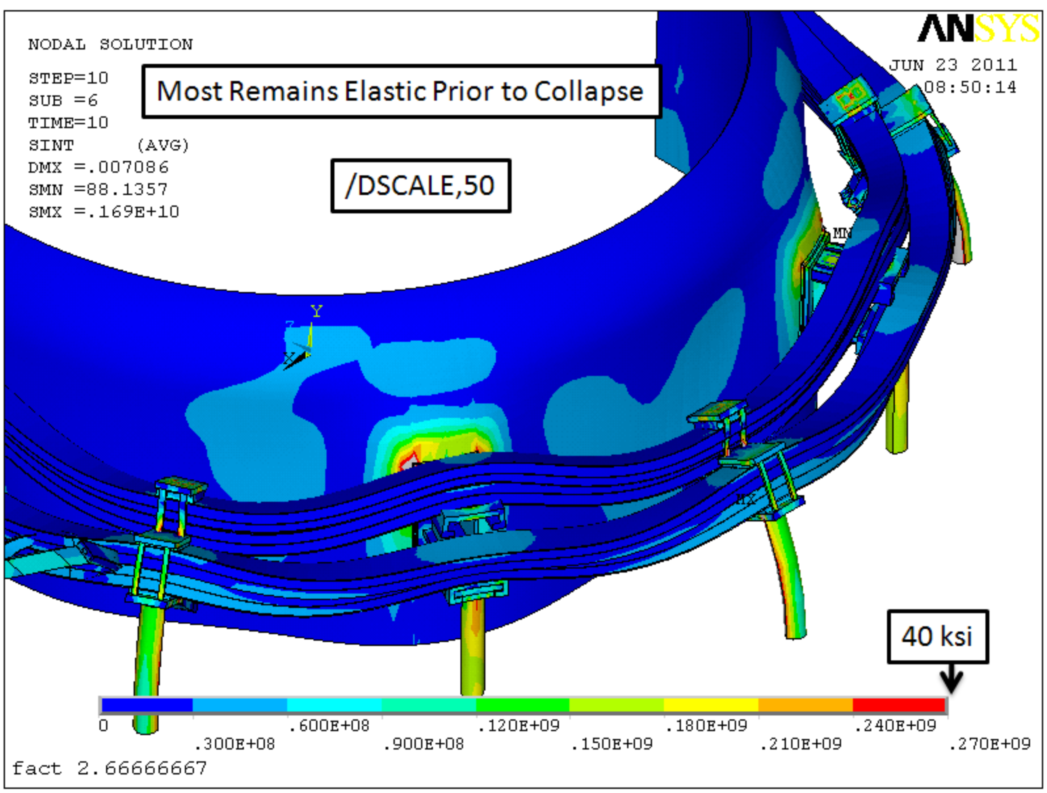


Figure 14.0-5 Large Displacement Tresca Results with a Load Multiplier of 2.6

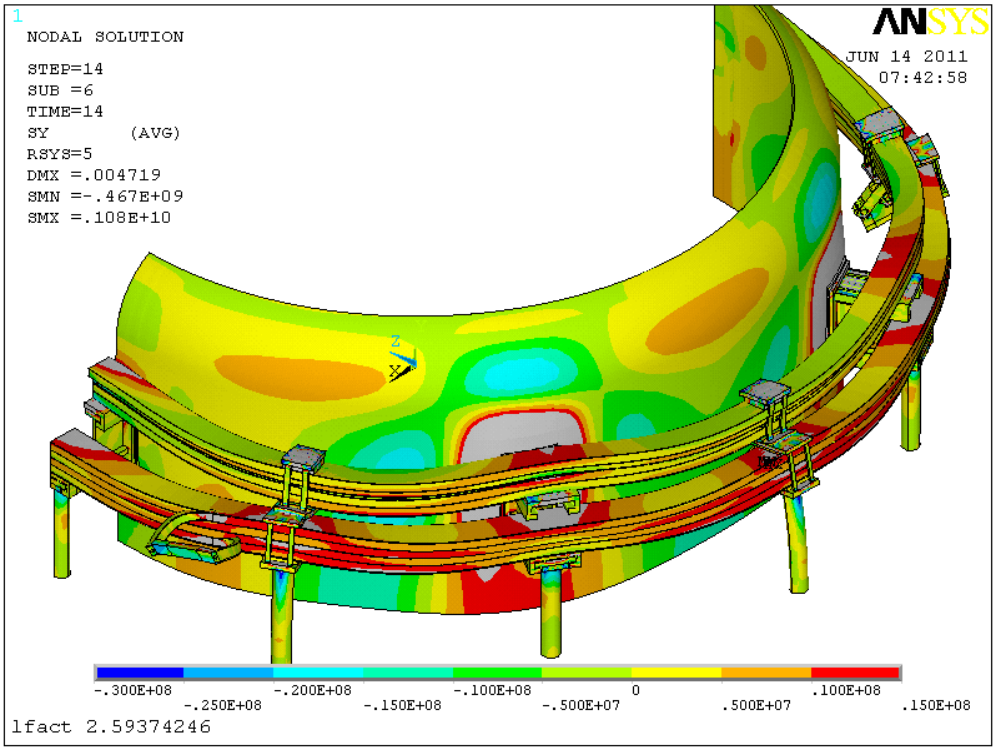


Figure 14.0-6 Vertical Stress with a load multiplier of 2.6

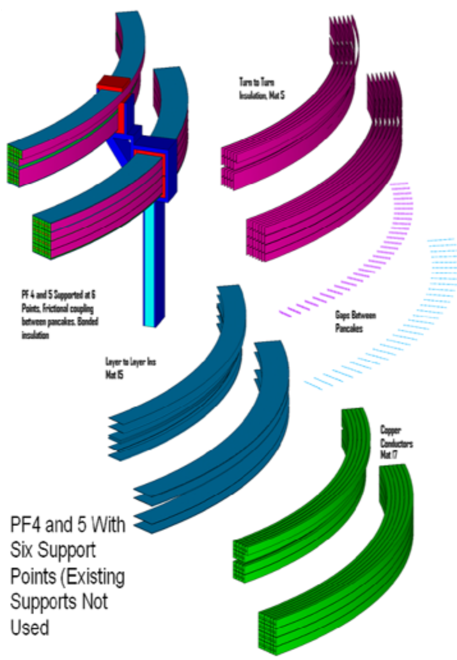
Appendix A Analysis of Earlier Concepts

A.1 Feasibility of 6 vs. 12 Support Points

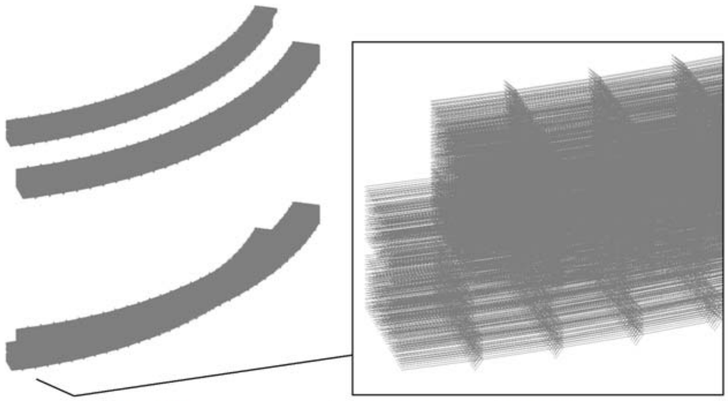
Currently (2011), both PF4 and 5 are supported by six support brackets welded to the vessel shell (12 including uppers and lowers). This study investigated the use of 6 supports for the upgrade loads. The PF5 insulation system is a mylar wrapped fusifab epoxy system. Because of the poor bonding of the mylar to epoxy and to the copper conductors, and because of copper stresses - particularly in PF4, twelve supports are necessary for the upgrade to reduce the spans and resulting bending stress.

Table a.1-1 Design Point Vertical Loads at the time of the Study

Fz(lbf)	PF4U	PF5U	PF5L	PF4L
Min	-204724	-241452	-50636	-85361
Worst Case Min	-423491	-523610	-191878	-151945
Max	85361	50636	241452	186601
Worst Case Max	151945	191878	523610	423491

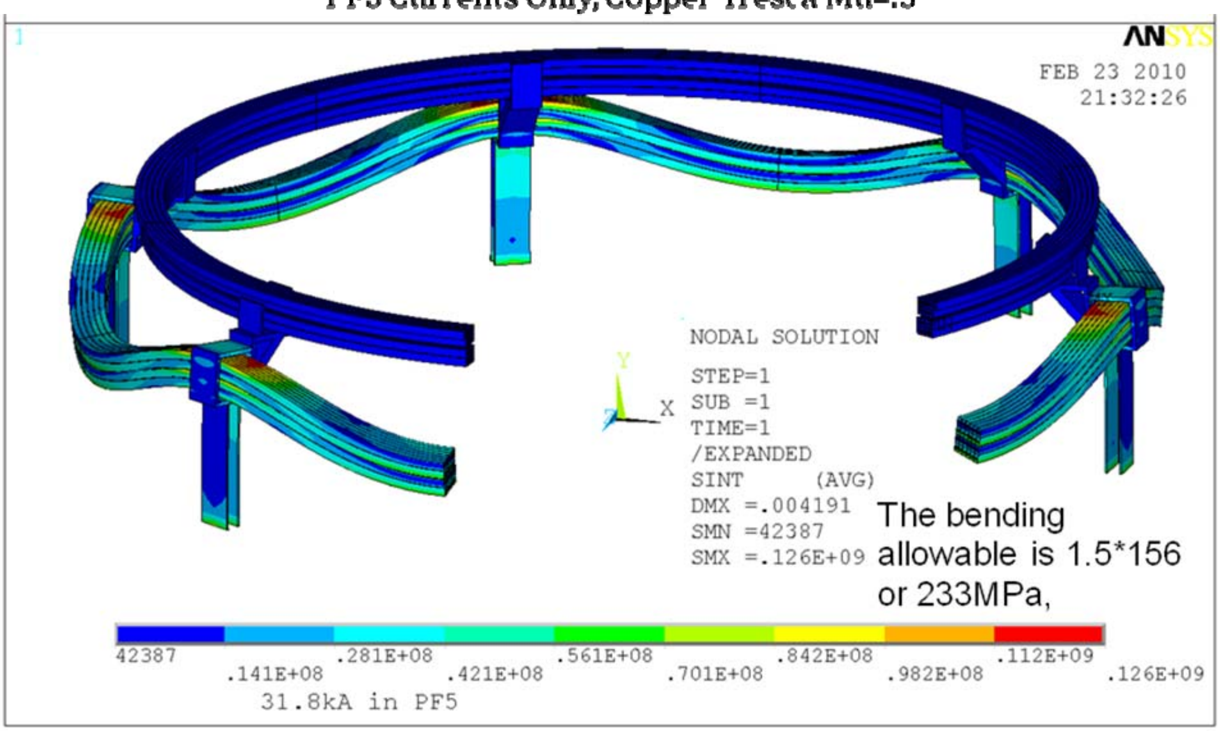


Biot Savart Current Sticks and Net Loads, 60 Degree Models

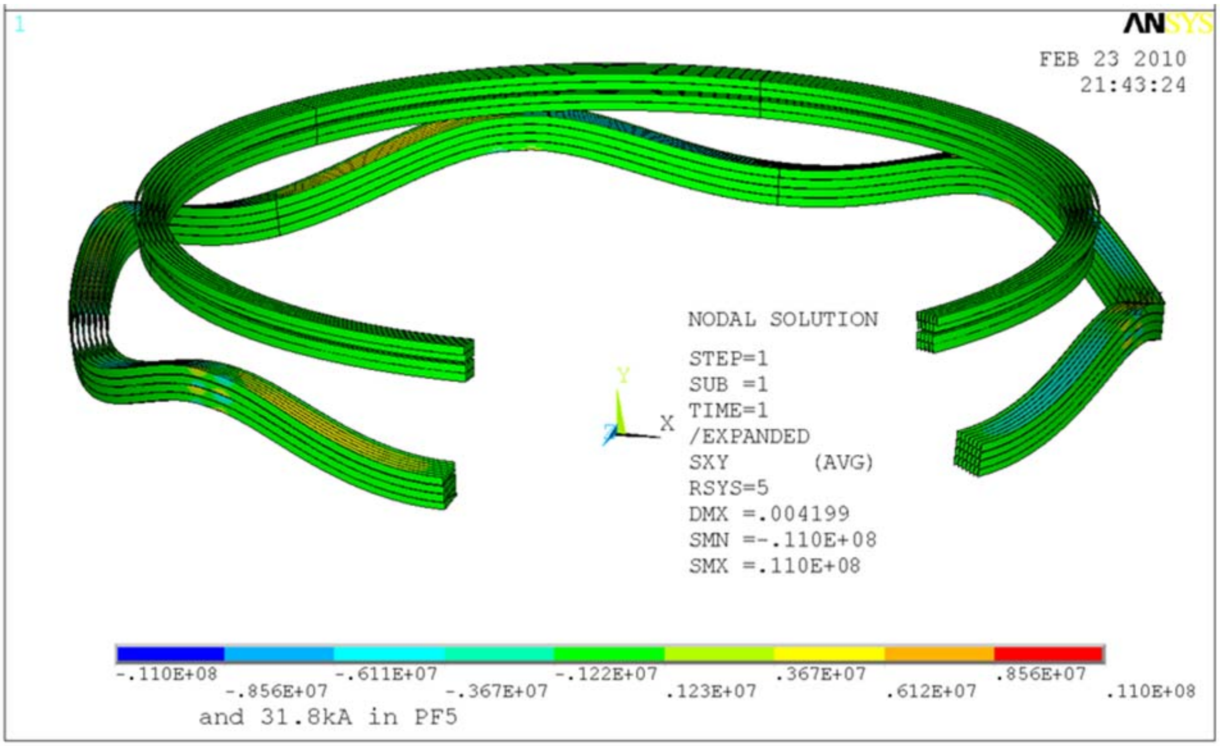


	ANSYS Reaction Load for 60 degree	ANSYS Full Coil	NSTX Design Point Spreadsheet 96 Scenarios
PF 4,5 U&L Fully Energized PF416kA PF5 31.8kA	244724 N	330083	291786
PF5 U&L at 31.8kA	154370	208214 46700lbs	241452

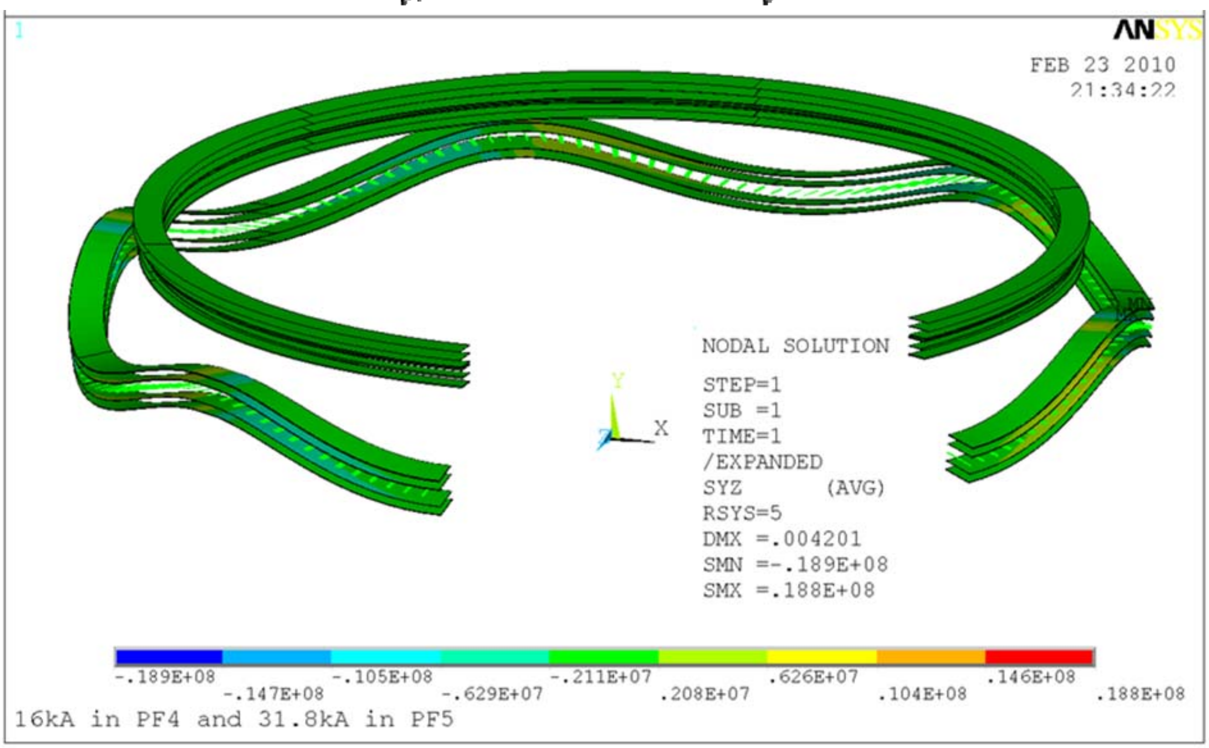
PF5 Currents Only, Copper Tresca Mu=.3



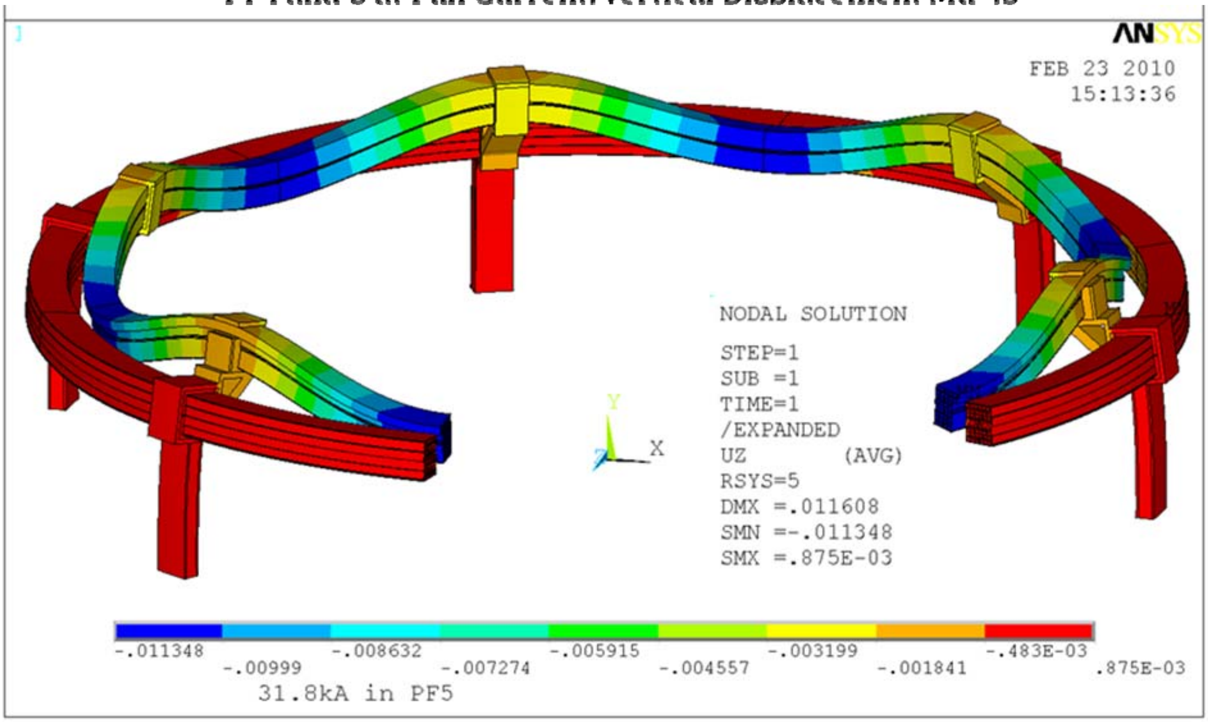
PF5 Currents Only, Rad-Theta Shear on Turn to Turn Insulation Mu=.3



PF5 Currents Only, Vert-Theta Shear on Layer Insulation Mu=.3

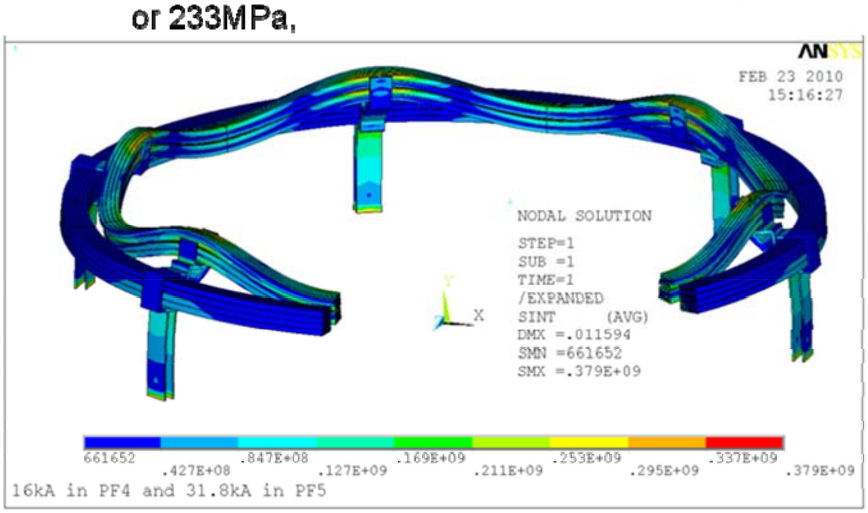


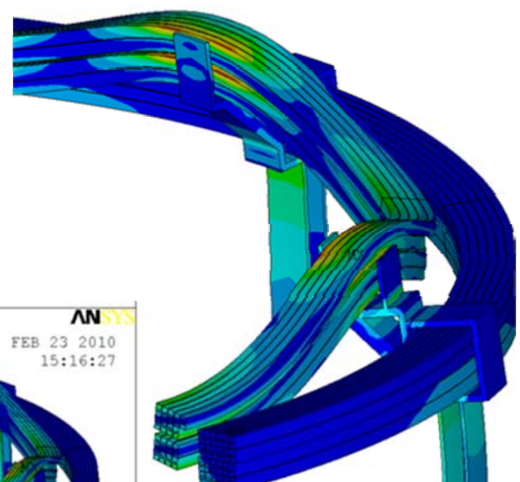
PF4 and 5 at Full Current. Vertical Displacement Mu=.3



PF4 and 5 at Full Current, Tresca Stress Mu=.3

The Bending allowable is 1.5*156 or 233MPa,



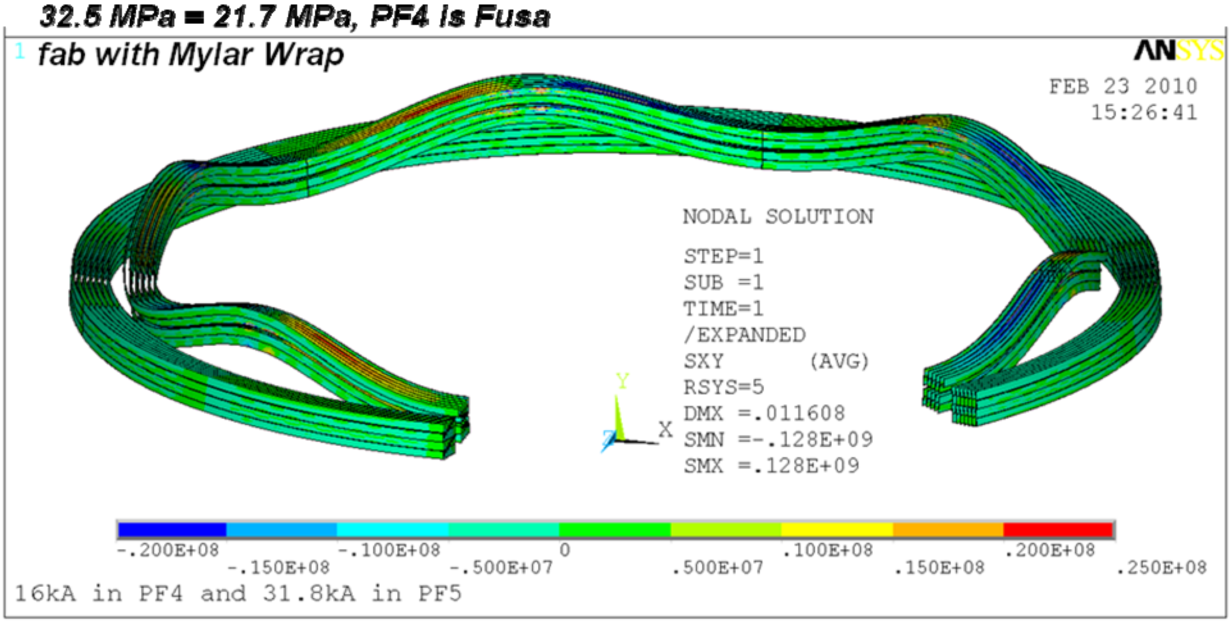


PF4 is Overstressed

With Mu=0.0 the PF4 conductor stress did not change. PF4 Pancakes appear to be separating

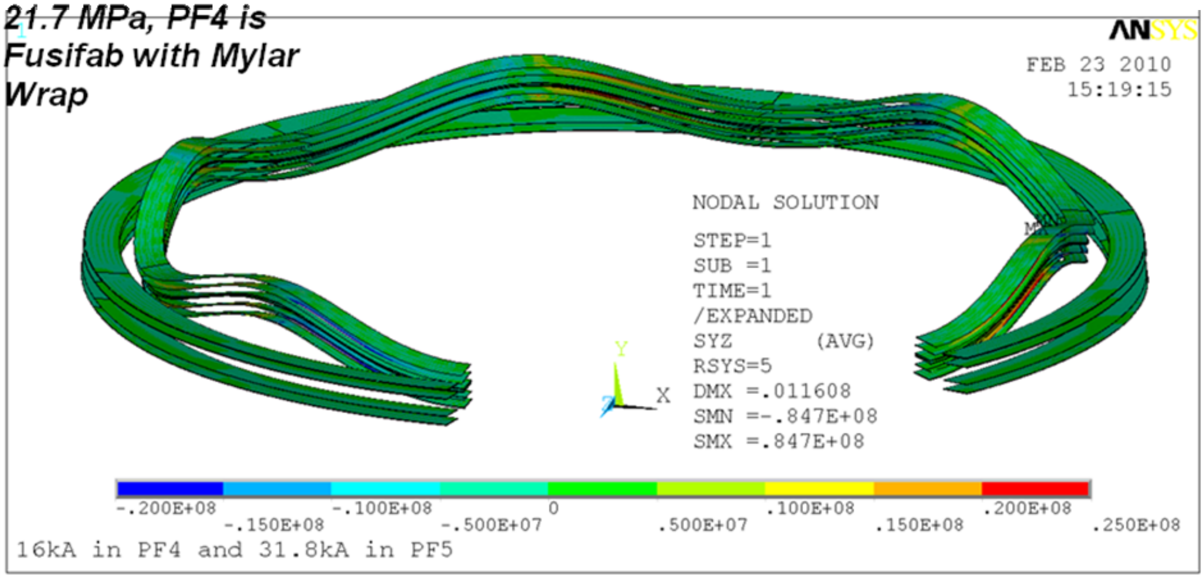
PF4 and 5 at Full Current, Insulation Radial Theta Shear on Turn to Turn Insulation Mu=.3

CTD 101K Allowable at RT 2/3 of 32.5 MPa = 21.7 MPa, PF4 is Fusa fab with Mylar Wrap



PF4 and 5 at Full Current, Insulation Vertical Theta Shear on Layer Insulation Mu=.3

CTD 101K Allowable at RT 2/3 of 32.5 MPa = 21.7 MPa, PF4 is Fusifab with Mylar Wrap



A.2 Results for Added Columns and Rubber Support Pads

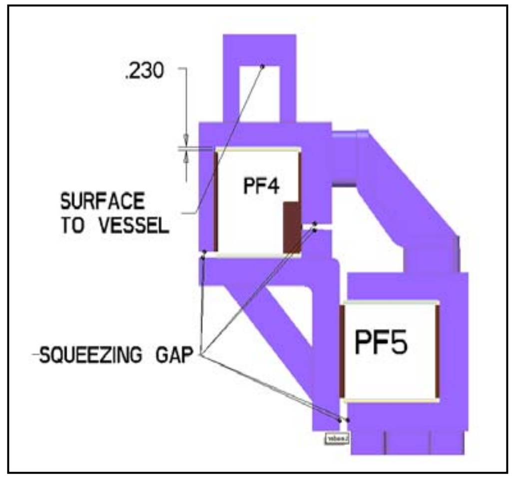
With the agreement that 12 columns were needed and that the existing columns would be used, the effort turned to providing centering features that would accommodate the differential heat-up of PF4 and 5. Rubber blocks were suggested to allow differential motion between the coils at the added support columns/brackets. The pads that were analyzed had too high a shear stiffness and didn't allow the needed compliance. Links and dovetail joints were suggested.

A.3 Support Concept in which the TF OOP loading is supported off the PF4 and 5 supports

This was a concept that attempted to transfer the out-of-plane loading to the vessel through the PF 4 and 5 support brackets. It put a twisting moment on the bracket and the weld stresses were unacceptable.

Table A.2-1 Net Loads on the PF4 and 5 Assembly

Fz(lbf)	(PF4U+PF5U)-(PF4L+PF5L)
Min	-502240
Worst Case Min	-1065883
Max	-108545
Worst Case Max	44617

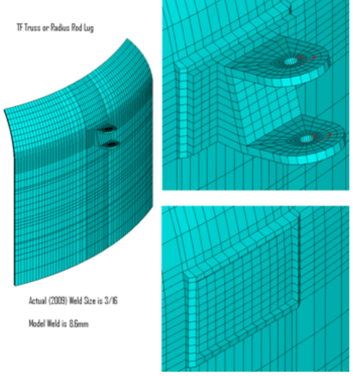


Support of OOP
Loads Off Vessel

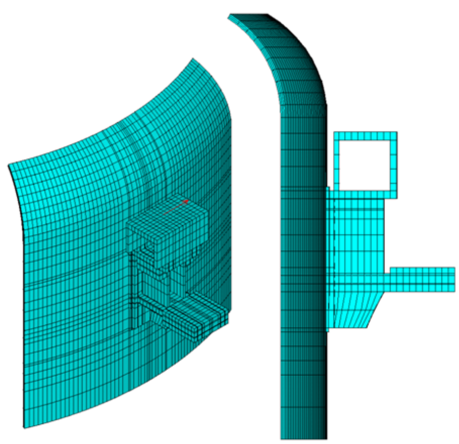
Han/Neumeyer 'Worst" =22000lbs
Titus Global 70 of 96 = 24000 Lbs
Danny Conservative Envelope Estimate = 50,000 Lbs
Adjust for TF Radius/Attachment Radius
Use 30,000 Lbs

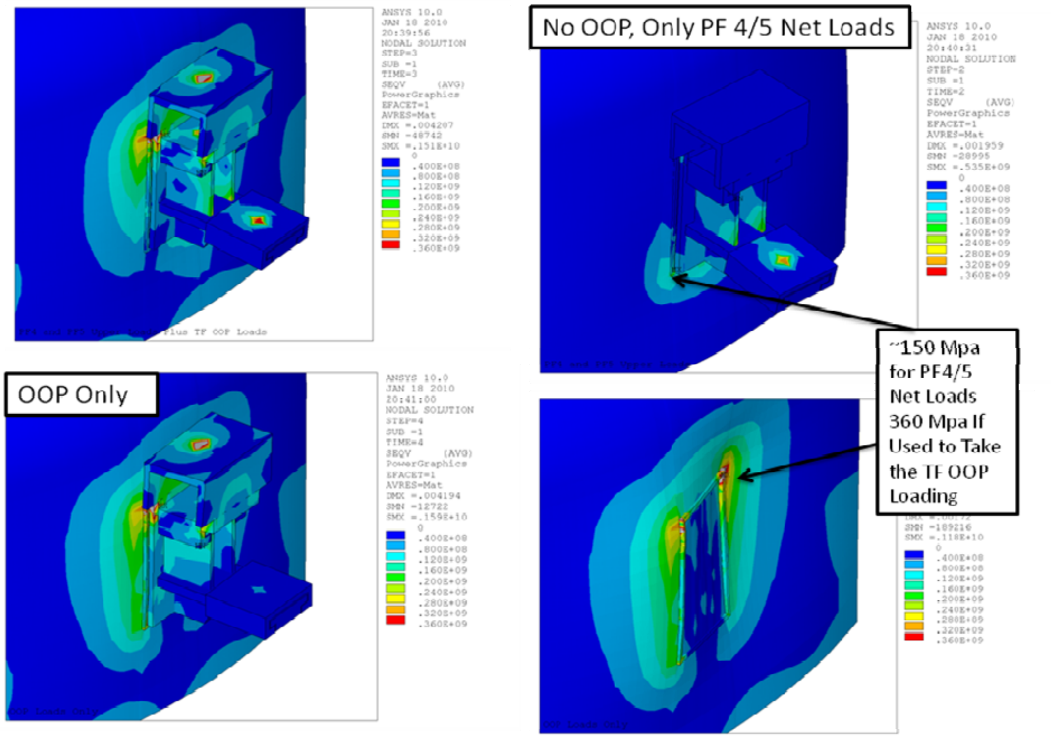
12 Attachment Points 30000lbs @

Note: 3/8" bolts don't work. Must be replaced with weld or much larger bolts



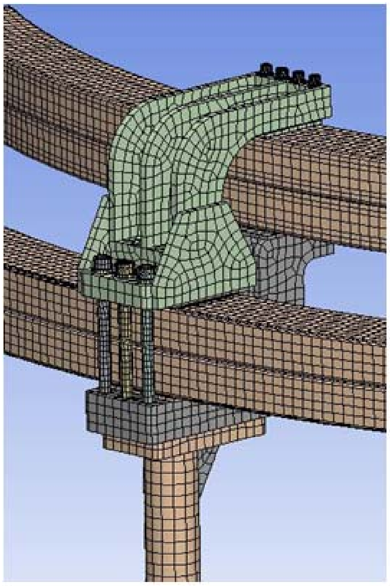
6 Attachment Points 60000lbs@

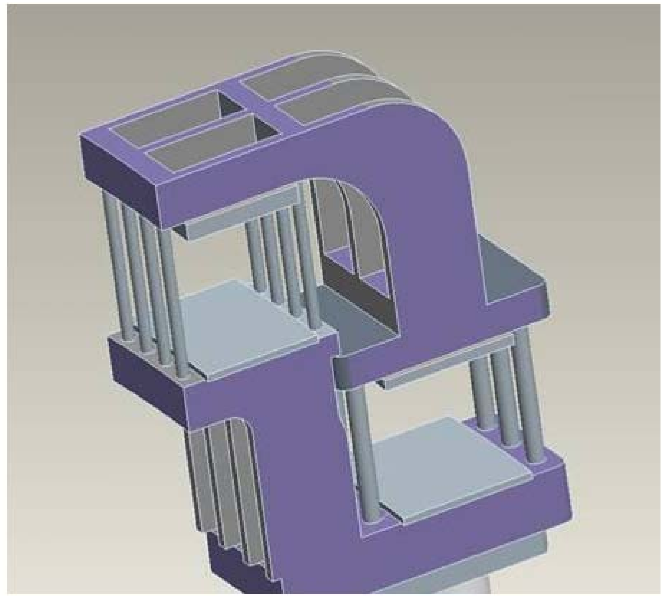



No OOP, Only PF 4/5 Net Loads
OOP Only
~150 Mpa for PF4/5 Net Loads 360 Mpa If Used to Take the TF OOP Loading

A.4 PDR Clamp Concept

This clamp detail, which was presented at the PDR, did not have a feature that would have allowed PF5 and PF4 to have different operating temperatures. Also the clamping behavior was difficult to implement and analyze because a common clamp was used for both coils. This was analyzed by Larry Bryant and there was difficulty obtaining convergence, consistent with the mechanical uncertainty of how the single clamp would interact with the two coils. .





Appendix A5
Stress Multipliers for the PF4 and 5 Clamp Weld in the Existing NSTX (2010)

The existing PF 4 and 5 supports were modeled and loads based on the upgrade design were applied. This analysis is representative of only the up-down symmetric attractive loads. The loads that were applied are shown in the table below. These are 1/6th the loading that would be appropriate for the whole of PF4U and PF5U coils. These loads produced 30,555 psi in the weld that holds the bracket to the vessel. The allowable stress in the weld is a function of the weld profile and the QA/inspection level applied to the weld. For visual inspection, a weld efficiency of 0.7 was assumed. If the weld was liquid penetrant inspected, a weld efficiency of 1.0 would be assumed.

Applied Loads on the model with a Resulting Weld Stress of 30555 psi	Allowable Load based on Visual weld inspection and an allowable weld stress of 14ksi	Allowable Load based on Visual Plus Penetrant weld inspection and an allowable weld stress of 20ksi
Due to PF4U: 17,000 Lbs Plus PF5U: 20,000 Lbs = 37000 lbs	16,900 Lbs	24,200 Lbs

Applied Loads on the model with 22,200 Lbs in the Strut	Allowable Load based on minimum AISC A307 bolting double shear allowable of 8.84 kips	Allowable Load based on Fy=36ksi steel, (e.g., A-36) for a double shear allowable of 9.54 kips
PF4U: +PF5U = 37000 lbs,	14,700 Lbs	15,900 Lbs

The strut bolt stress is limiting for the case where the loads in PF4/5 are just attractive. Weld stresses double for the same loading if the strut is removed. If there is a net load on the PF4/5U + PF4/5L assembly, then the strut does not contribute to supporting this load component, and the allowable load from only a net assembly load would be 8 kips top and bottom or 16 kips total. So one rule or guide would be the following:

The (Attractive Load on PF4/5U to PF4/5L + the net load on PF4/5U and L assembly) should be less than 16 kips.

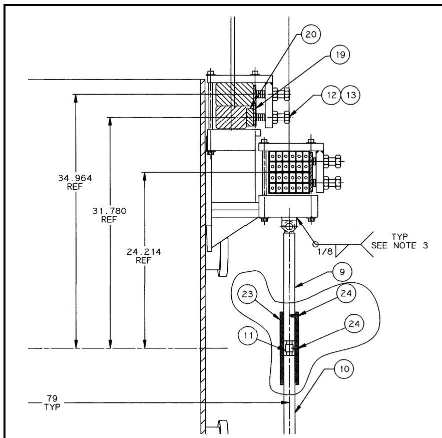


Fig 9.3-1 Existing PF4 and 5 Support

In this analysis, PF4 and 5 loads are grouped together. PF5 loading has a larger moment arm and has a bigger effect on the weld and strut bolt stress. To be strictly correct, the PF5/PF4 load ratio should be as assumed in the analysis. Only the bracket to vessel weld and the strut end bolts were looked at. It is assumed that the buckling of the strut was addressed when it failed, and that there is adequate margin against buckling at present. Also, it is assumed that only compression loads are taken by the strut (the 1/8-inch welds that connect the strut clevis to the bracket are too small). (Note that a new, larger column is being used in the upgrade)

Analysis

The weld is nominally 5/16-inch, but the QA report recommends that it be treated as an effective ¼ inch weld. To facilitate meshing the weld, an arbitrary cross section is used then the weld stress is scaled by the ratio of the weld section in the model to the actual weld section. In this case, the weld was intended as a fillet, but material has been added to accommodate the vessel curvature, and the resulting weld was derated. The weld is assumed to have a larger cross section than a fillet, so the standard 0.707 factor was not applied. The weld allowable is a function of the level of inspection that is applied. At PPPL, only visual inspection is routine. ASME would require a weld efficiency of 0.7 or lower.

```
/title,PF4 and PF5 Upper Loads
!Remove OOP Loads
bf,all,temp,20
f,436,fz,-204000/12/.2248
f,1098,fz,-241000/12/.2248
Solve
```

PF4/5 Weldment
Nominal Weld = 5/16 in.
QA Effective Weld = 1/4
FEA Weld Model Thick =10mm
Weld Stress =90*(.01*39.37)/.25
=142 MPa = 30555 psi

Ron: Scale Weld Stress by ratio of your forces to those that I applied

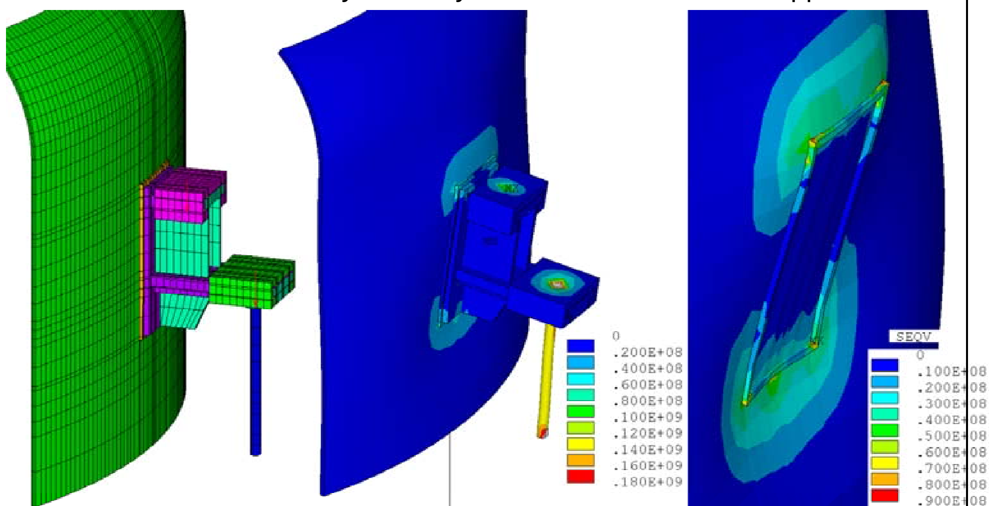


Fig 9.3- 2 - In-Plane PF4U and 5U Loads With Strut

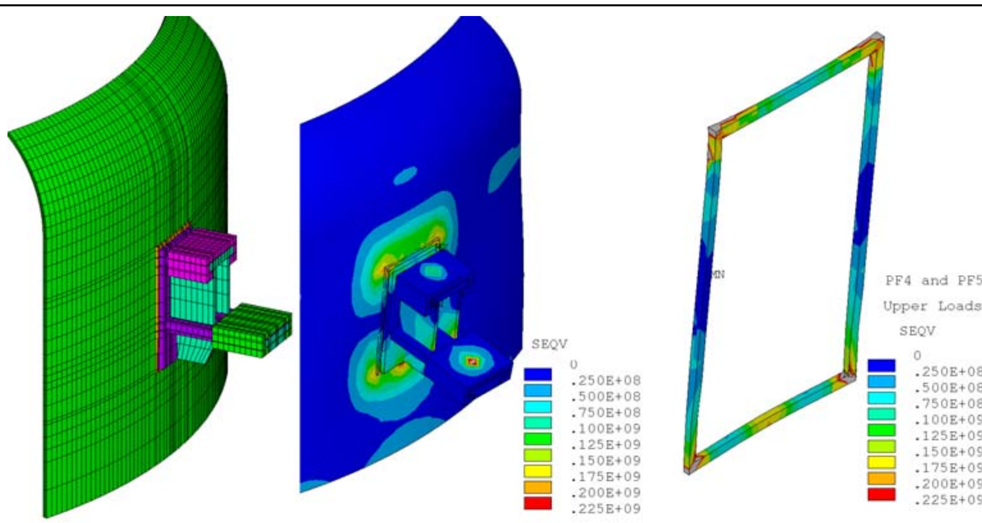


Fig 9.3-3 - If the strut is removed, the weld stresses approximately double.

Bolt capacity

The strut is modeled as 3 cm in diameter. For the upgrade loads, the stress in the strut is about 140 MPa, so the load is 98.9l kN or 22,200 lbs.

The shoulder bolt that takes the strut compression load is a ¾ inch 304 SST bolt in double shear. The AISC allowable for an A307 bolt is 8.84 kips (or 9.54 kips for Fy=36ksi steel, like A-36) in double shear. 304SS bolting could have a 30 ksi yield, but is likely closer to the A36 yield due to roll forming of the bolt.

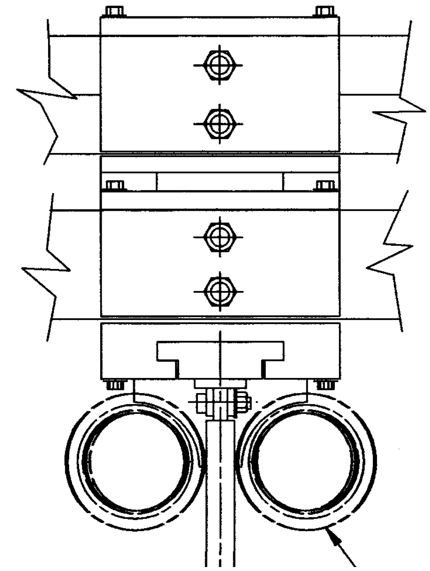
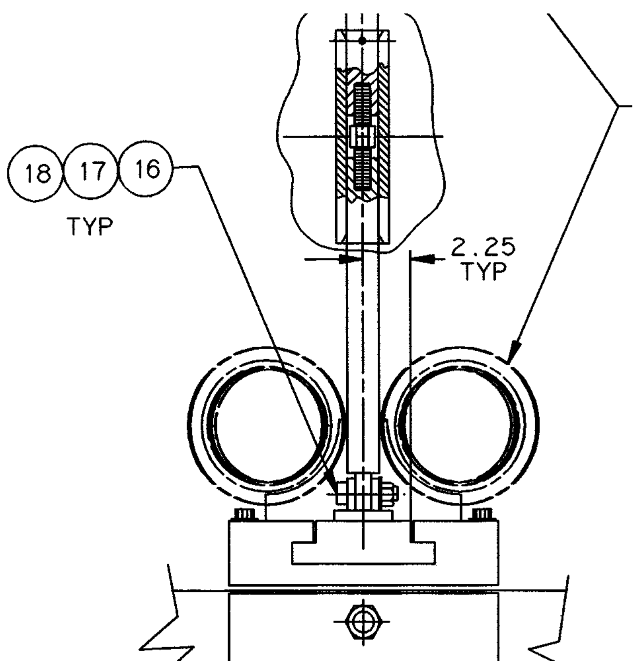


Figure 9.3-5 PF4 and 5 Strut Bolting Detail

18	5/8 FLATWASHER (MODIFIED)	COMM	316 STN STL
17	5/8-11 HEX NUT	COMM	316 STN STL
16	3/4 DIA X 1 1/2 LG SHOULDER BOLT	MCMASTER CARR 90298A839	18-8 STN STL
15	1/2 LOCKWASHER	COMM	316 STN STL



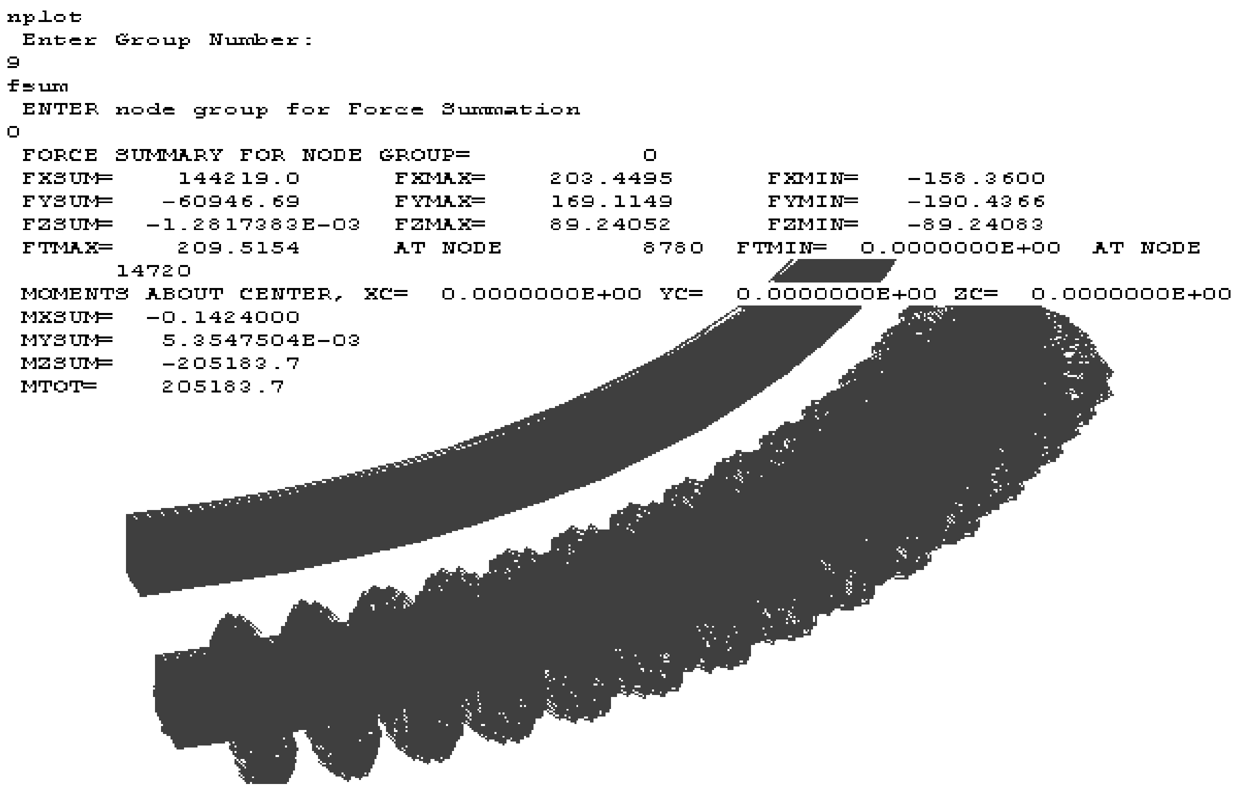
The Weld Allowable is 20 ksi with inspection and an efficiency of 1.0 and 14 ksi with a weld efficiency of .7 These are discussed in Figure 6.3-4 in Section 6.

Table 9.1-1 NSTX Centerstack Upgrade PF Loads

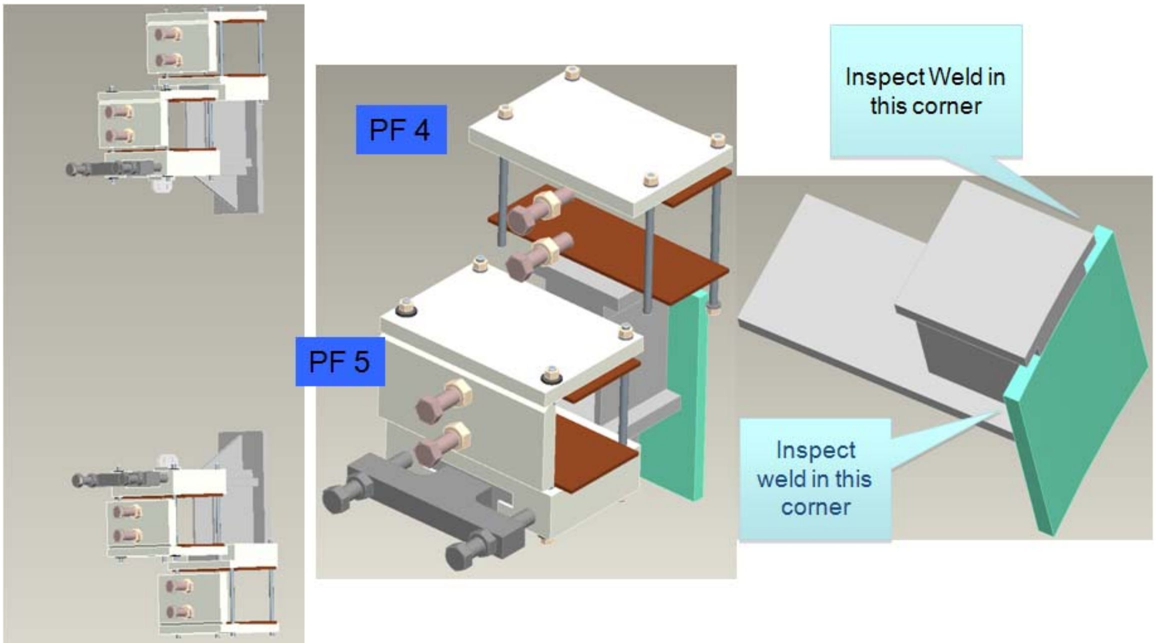
Fz(lbf)	PF4U	PF5U	PF5L	PF4L
Min	-204724	-241452	-50636	-85361
Worst Case Min	-423491	-523610	-191878	-151945
Max	85361	50636	241452	186601
Worst Case Max	151945	191878	523610	423491

Benchmark Check of 20 kA Current Operation of PF5 with Existing supports.

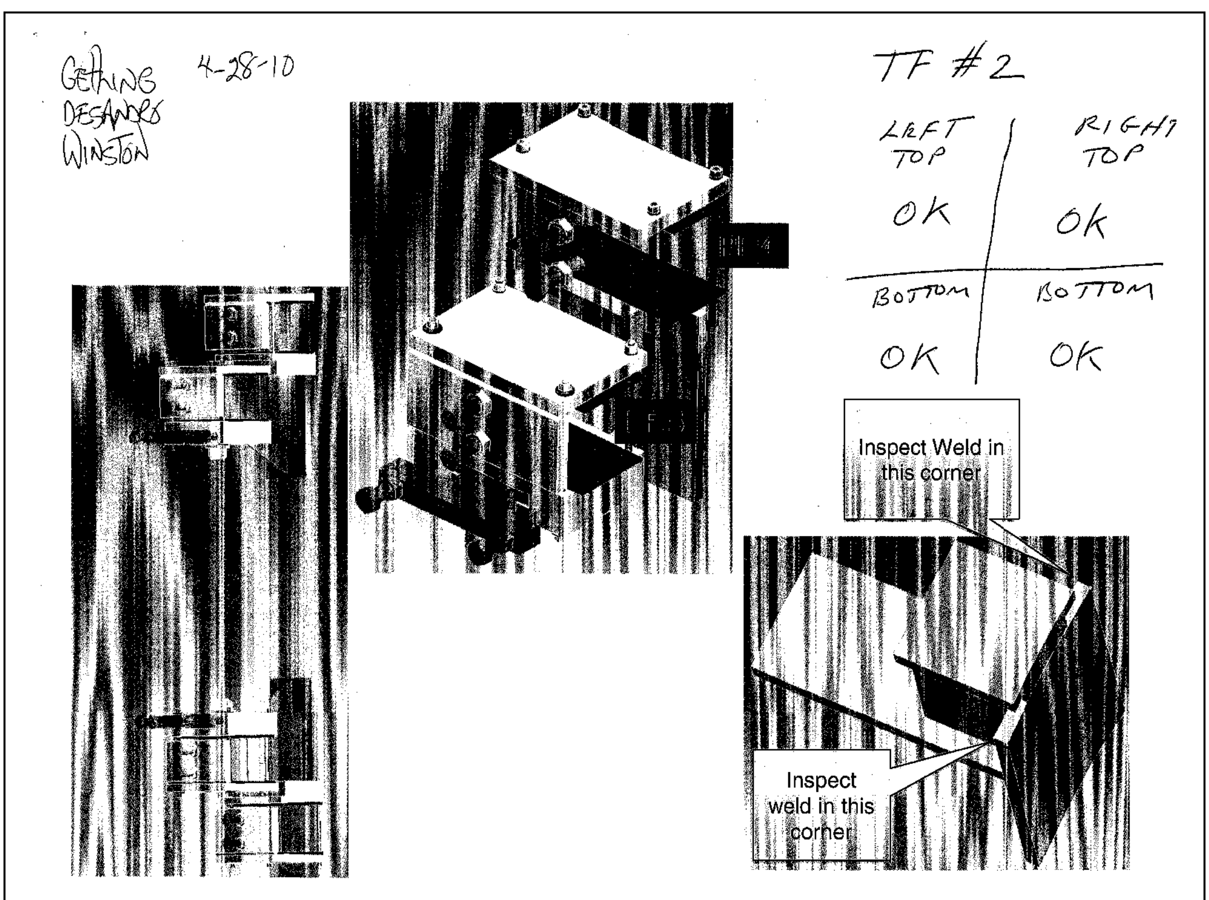
The calculation below only has PF 4 and 5 upper and lower modeled. With only currents in PF5, the analysis below shows 60 kN compared with 80 kN from Ron Hatcher's calculation with all PF currents active.



Appendix B
PF4/5 Bracket Support Weld Inspection



Pete,
The machine techs were able to get into several of the PF 4/5 support brackets with a borescope to inspect the welds. They looked at the brackets under TF coils 2,4,6,8,10,12. They were able to inspect the upper corners in all cases and the lower corners in most cases. No signs of any cracks or distress. Winston said if we wanted to look at some in person they could get in again on Thursday evening.
Larry



TF # 8

LEFT TOP	RIGHT TOP
OK	OK
BOTTOM	BOTTOM
OK	OK

TF # 10

LEFT TOP	RIGHT TOP
OK	OK
BOTTOM	BOTTOM
OK	OK

TF # 12

LEFT TOP	RIGHT TOP
OK	OK
BOTTOM	BOTTOM
OK	NA Could not REACH

Appendix C References

Reference 11

Pete,

"LPPI" is a term I came up to describe the nominal upgrade target, namely a 5 second (long pulse) plasma flat top where the OH current does not complete the second swing, only delivering part of its double-swing flux. The remaining flux is supplied non-inductively. Thus LPPI stands for "Long Pulse Partial Inductive".

"SPFI" is another operating mode I felt the need to describe because it forces the design to contend with the full second swing current. In this case the pulse has a flat top less than 5 seconds (short pulse) but the full OH double-swing flux is used and it is sufficient to drive the current without reliance on non-inductive means. In this case it turns out that the flat top duration is limited by the OH I2T, not the available OH flux, which is more than sufficient per my plasma model.

So, these two cases bracket how the machine will operate.

You can see this here:

http://www.pppl.gov/~neumeyer/NSTX_CSU/PF_Coil_Summary.htm

I have not put this in the GRD, but I can if you like. In fact the SPFI condition is probably the design driver for many of the out-of-plane loads because it pushes the OH to -24kA second swing. The GRD calls for an OH flux of 2.0 Wb which we supply in the LPPI case. With the SPFI case and the full second swing we get 2.3Wb.

Chas

On Mar 29, 2011, at 2:27 PM, Peter Titus wrote:

Charlie: What do these mean? Long Pulse something? Short Pulse Someithing?
-Peter

Tmax_LPPI Tmax_SPFI

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Princeton, N. J. 08543
Tel: 609-243-2159
Mobile: 609-313-4738
Fax: 609-243-3266

Reference 12

April 5 2011 email from Jim Chrzanowski:

Pete

FYI- The PF-2, PF-3 and PF-4 were all manufactured by PPPL. Their insulation scheme is (4) half-lapped layers of Mylar insulation, followed by (2) half-lapped layers of Fusa-Fab" B-stage insulation.

Jim