NSTX

Global Model – Model Description, Mesh Generation, Results

NSTX-CALC-13-001-00

August 13, 2009

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Approved By:

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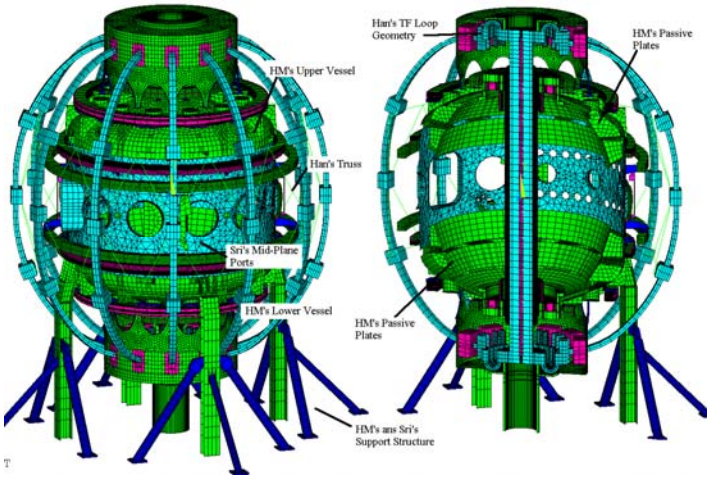
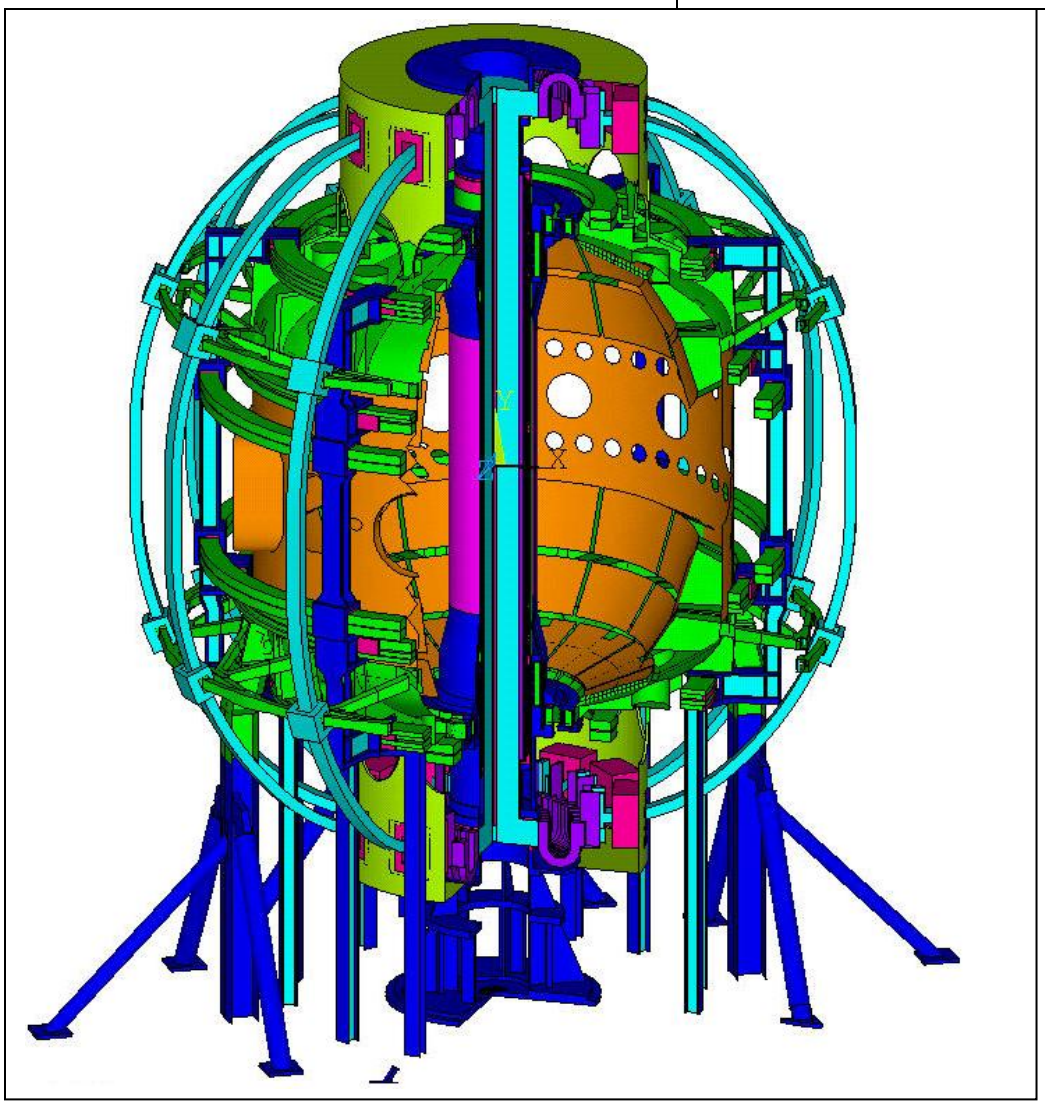
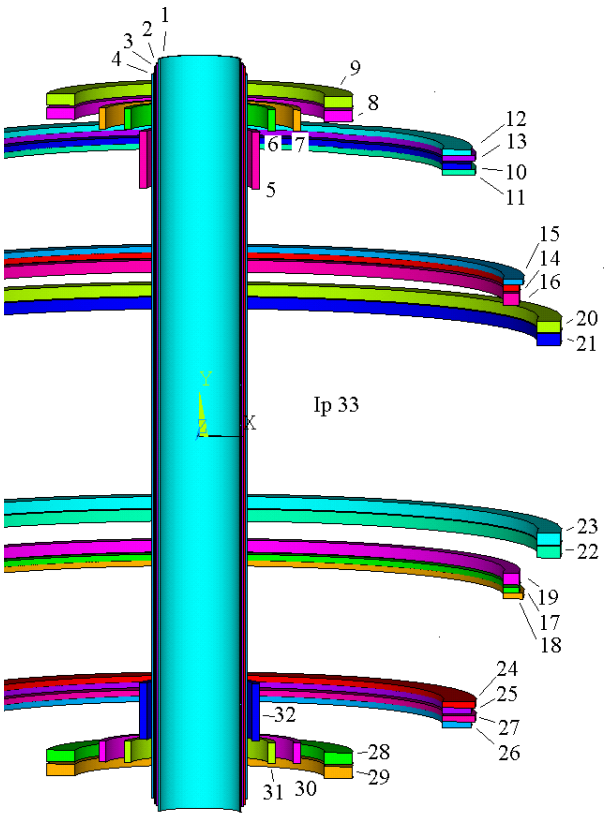
Executive Summary

Vertical and Radial force influence matrices were provided by Ron Hatcher(1). These were used in a Monte Carlo simulation which varied the coil current's within their allowable ranges and computed forces on the individual coils. The maximums and minimums were determined for 10,000 sets of randomly selected coil currents. This yields the worst case loading the power supplies can produce, and ignores the likely loading during plasma shots. The resulting loads and hoop stresses are useful in providing an upper limit on the mechanical loads on the coils. Forces on coil groups, such as PF4 and 5 upper can be summed and maxima and minima determined to provide design loads for specific structural elements or regions.

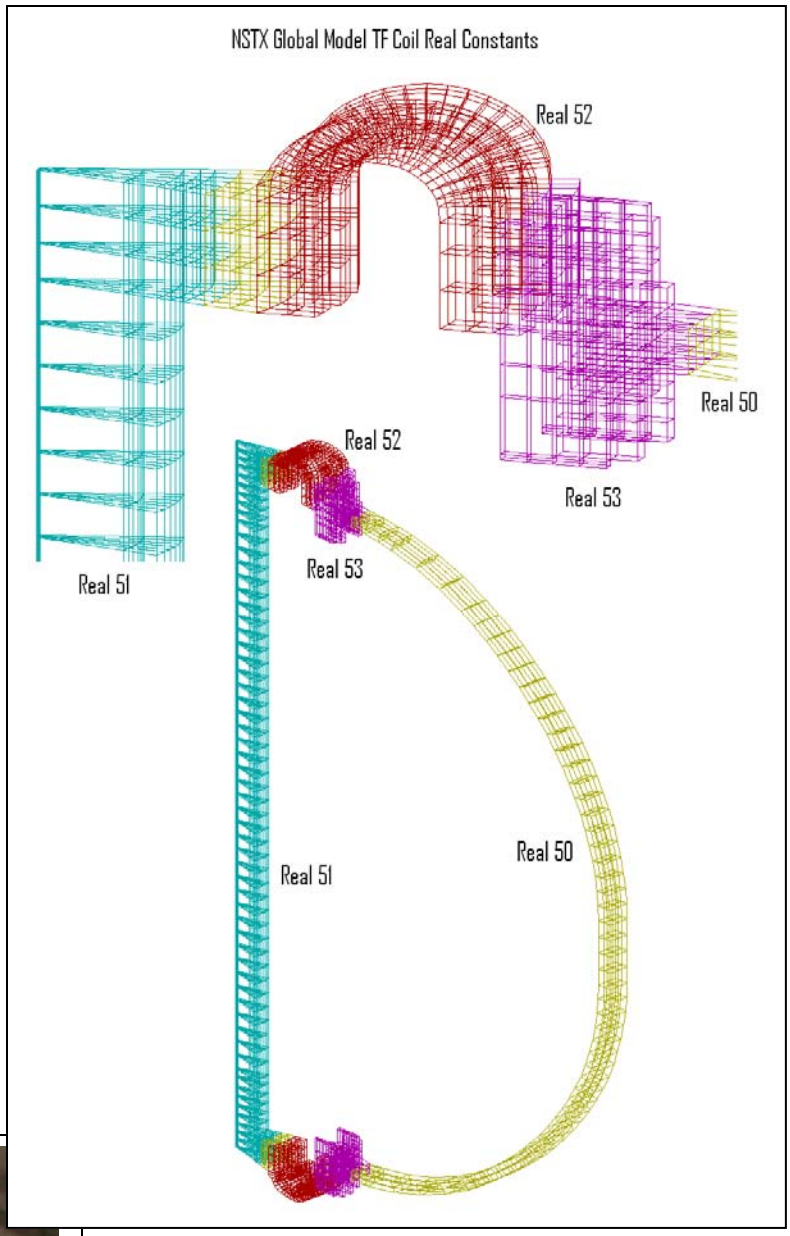


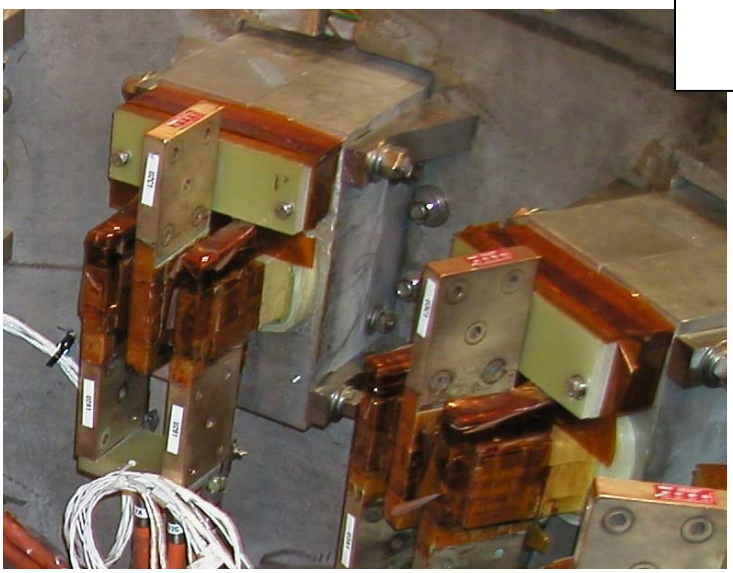
Global Model Status as of June 22 2009





PF Coil Real Constants



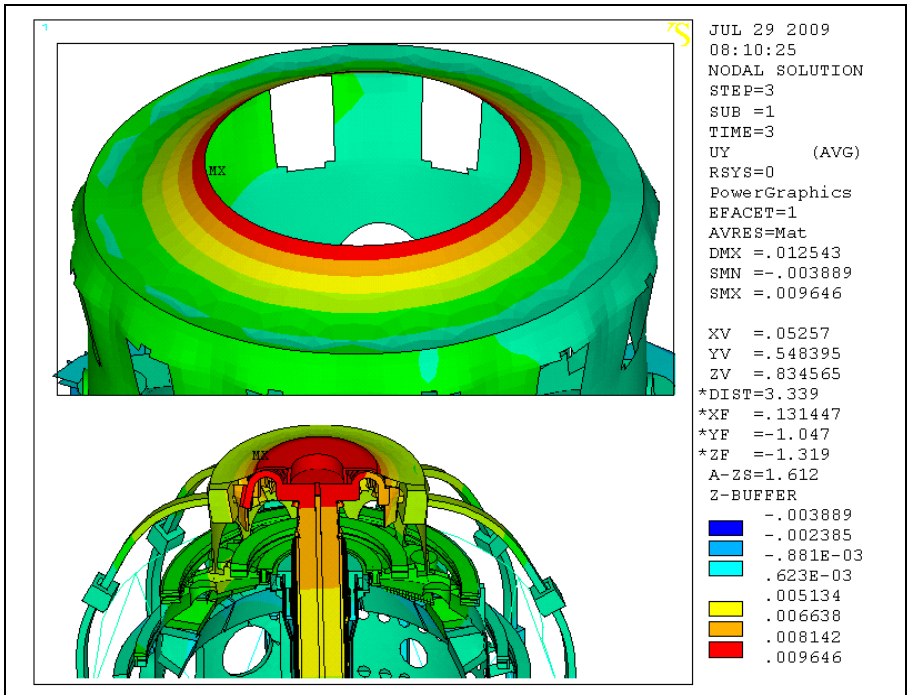


View Inside Umbrella Structure

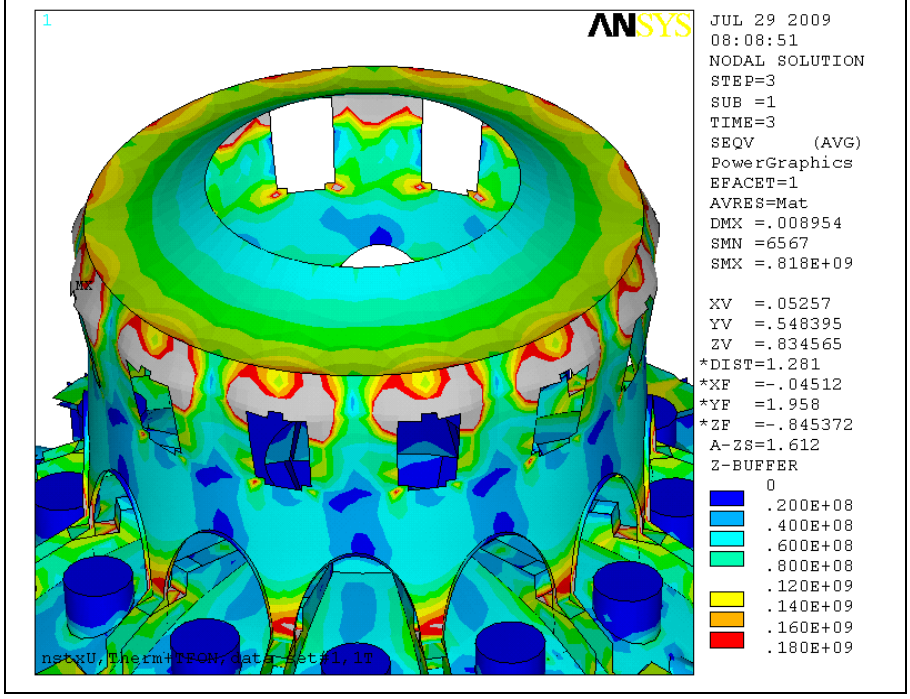
Upper Flex Plate/Diaphragm (Replaces the Gear Tooth Connection)

Hot Central Column, Cold Vessel

Central Column Expands 9mm



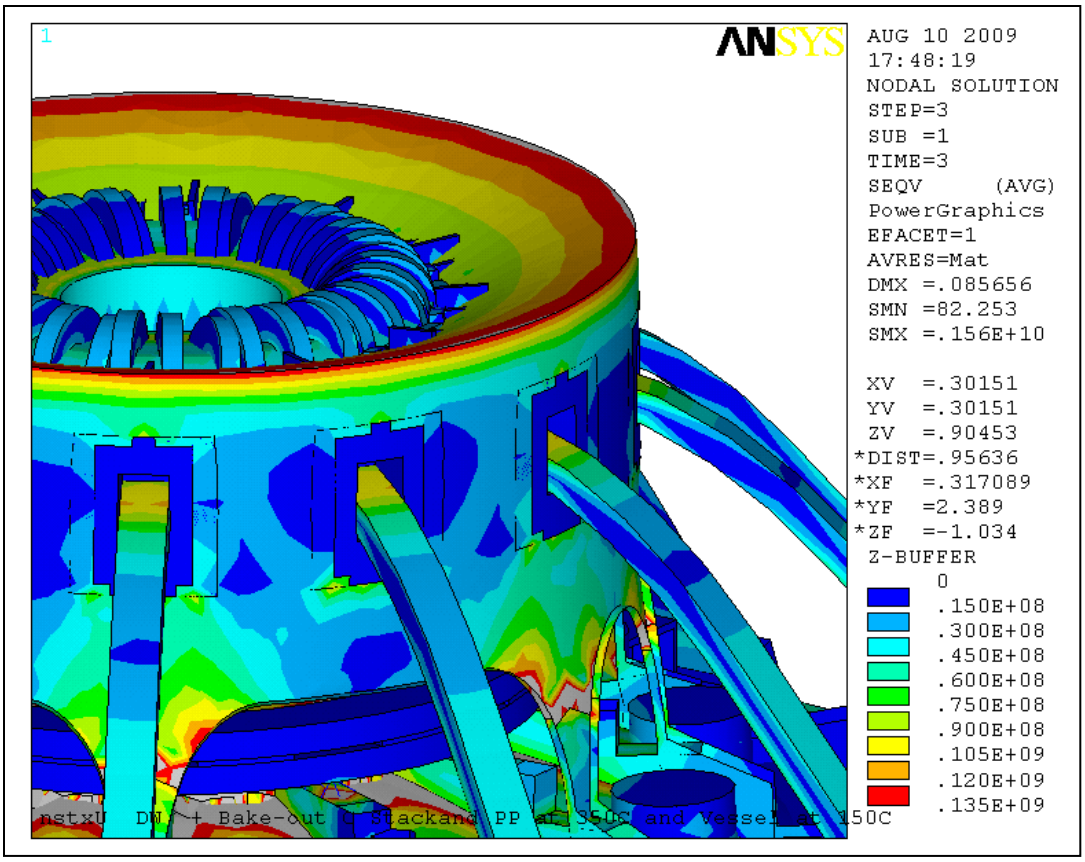
5/8” Flex/Diaphram, 150 MPa
Note Non-Uniform Stress when TF Expands



- Vessel at 150C during Bake-Out RT Central Column
- Vessel Expands +8mm

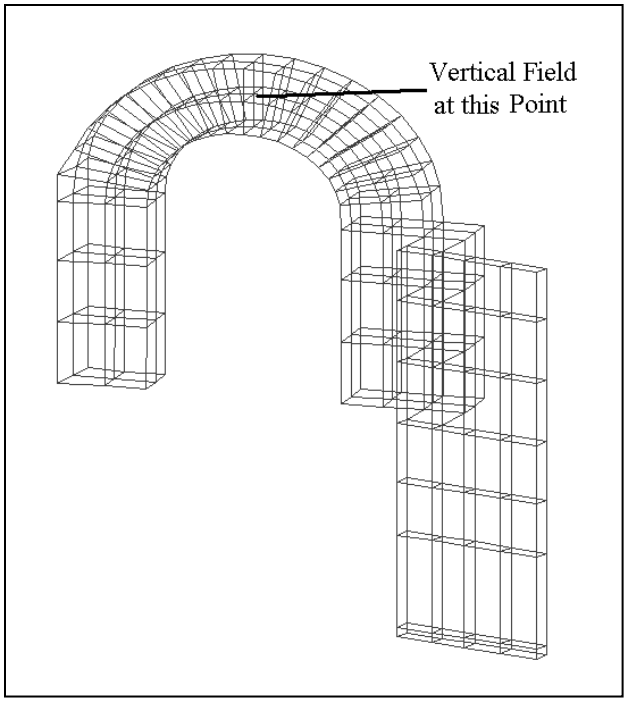
Flex/Diaphram Stress is 135 MPa

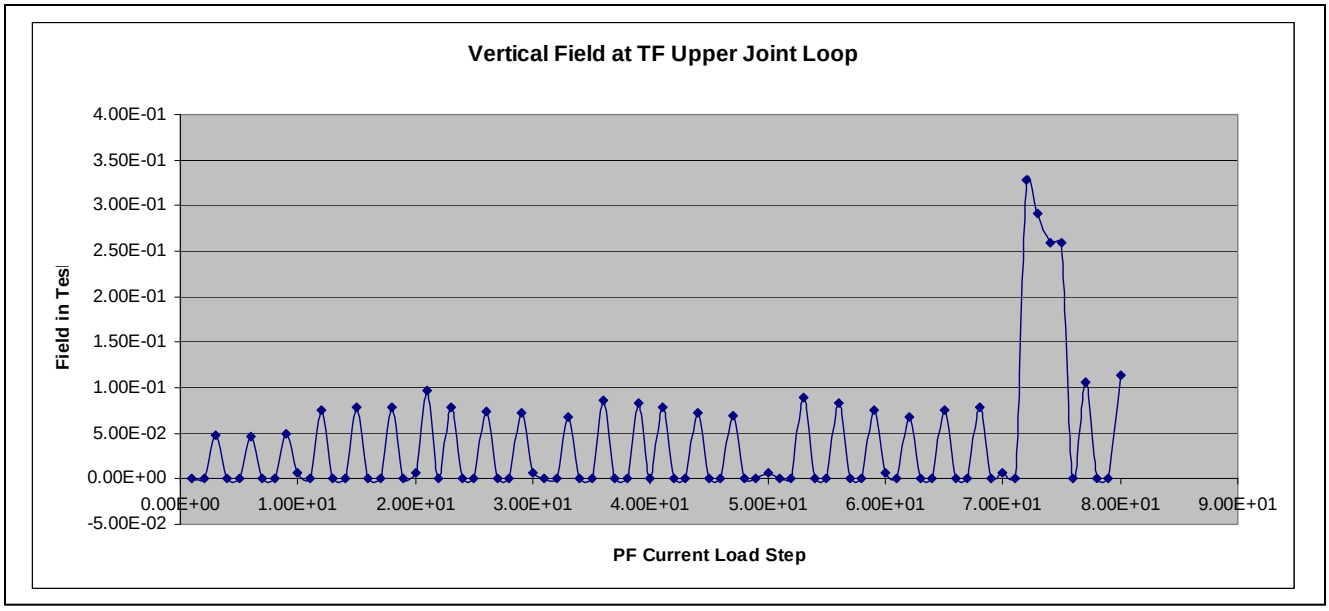
Note Uniform Stress at Edge

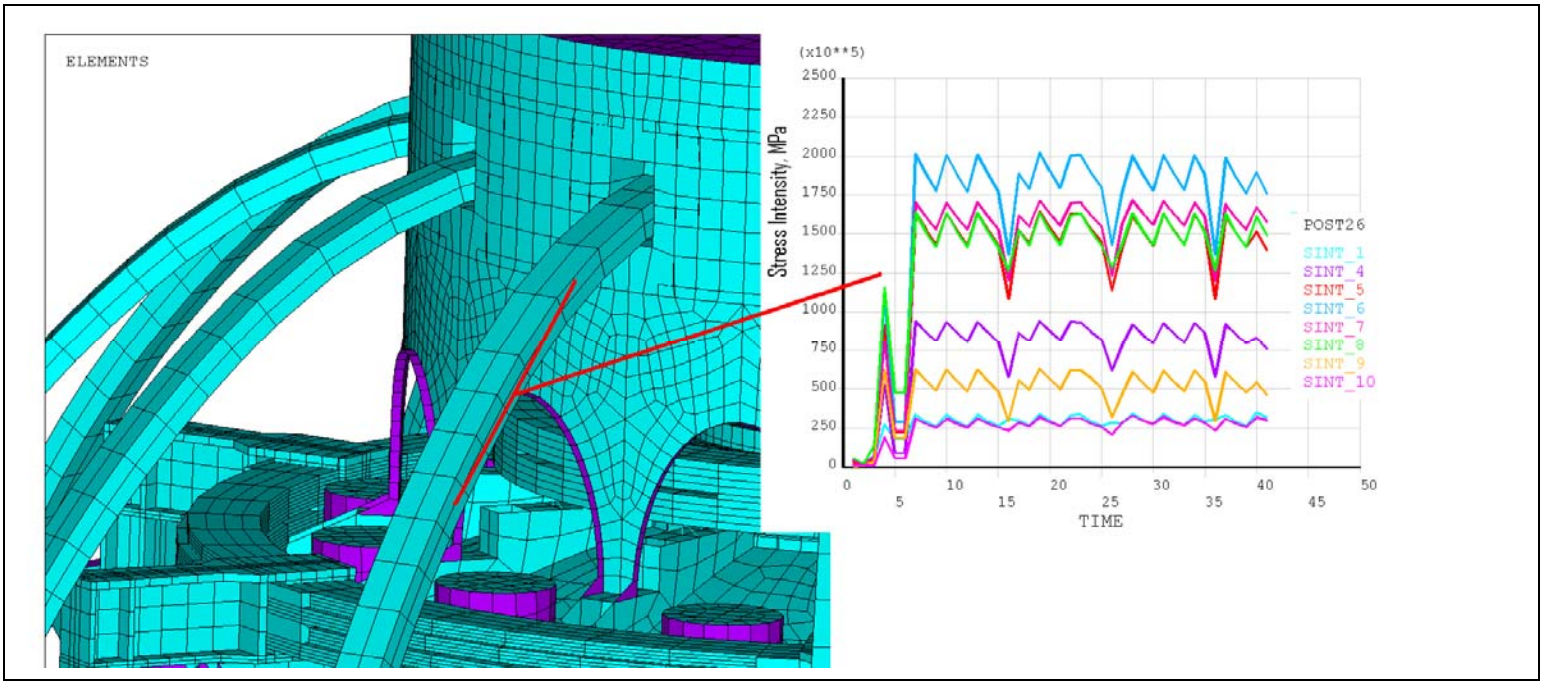


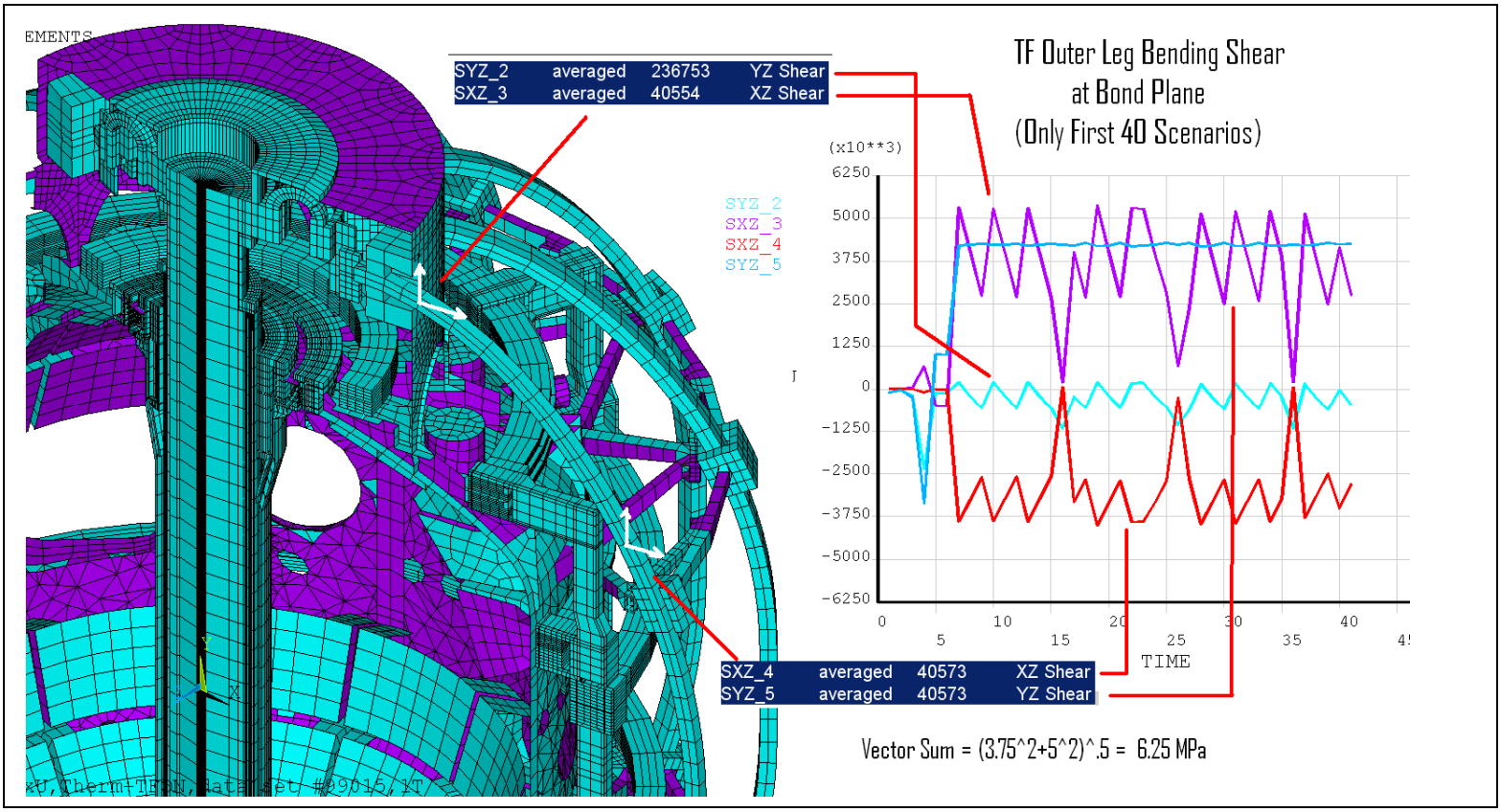
TF Joint “Loop” Vertical Field

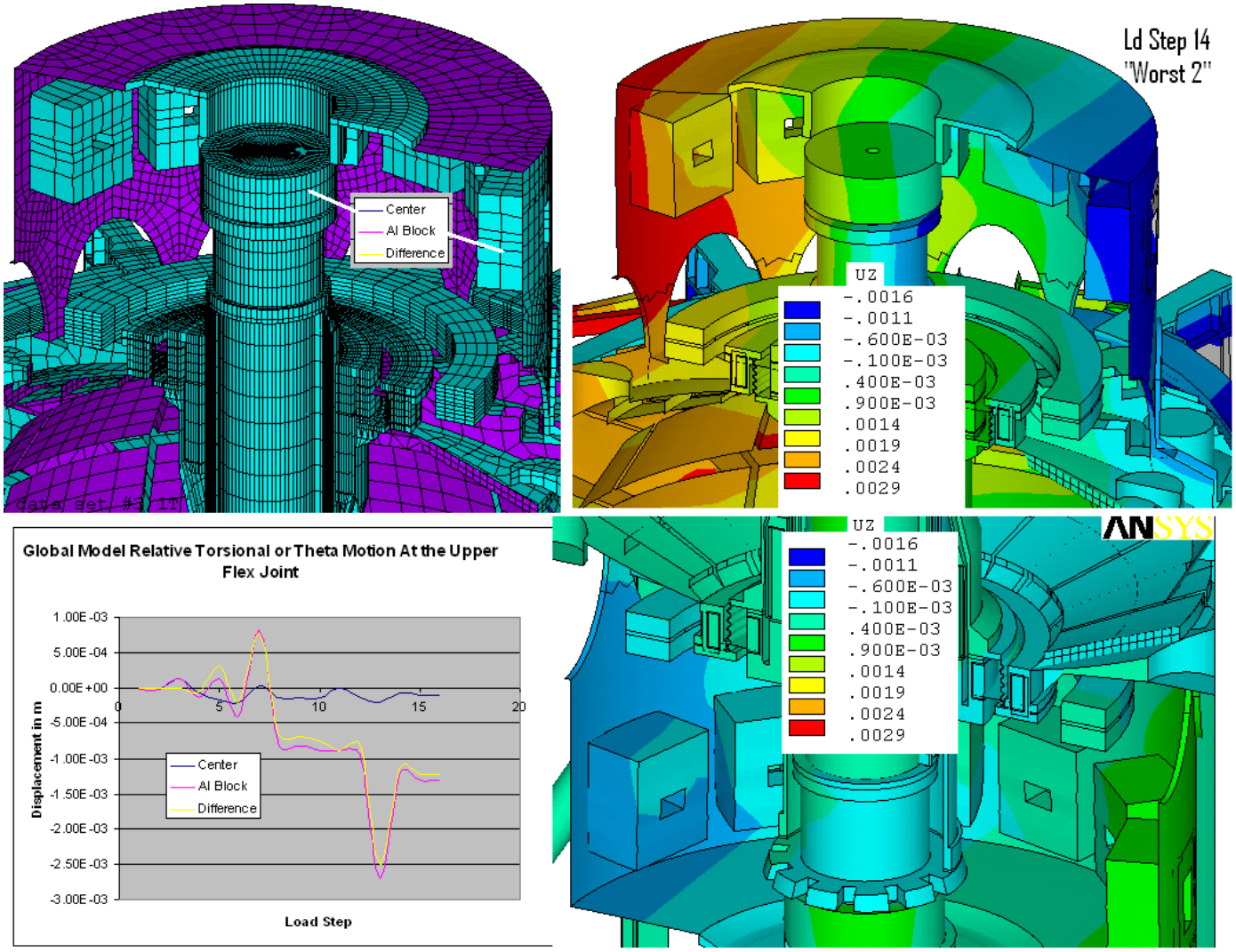
The





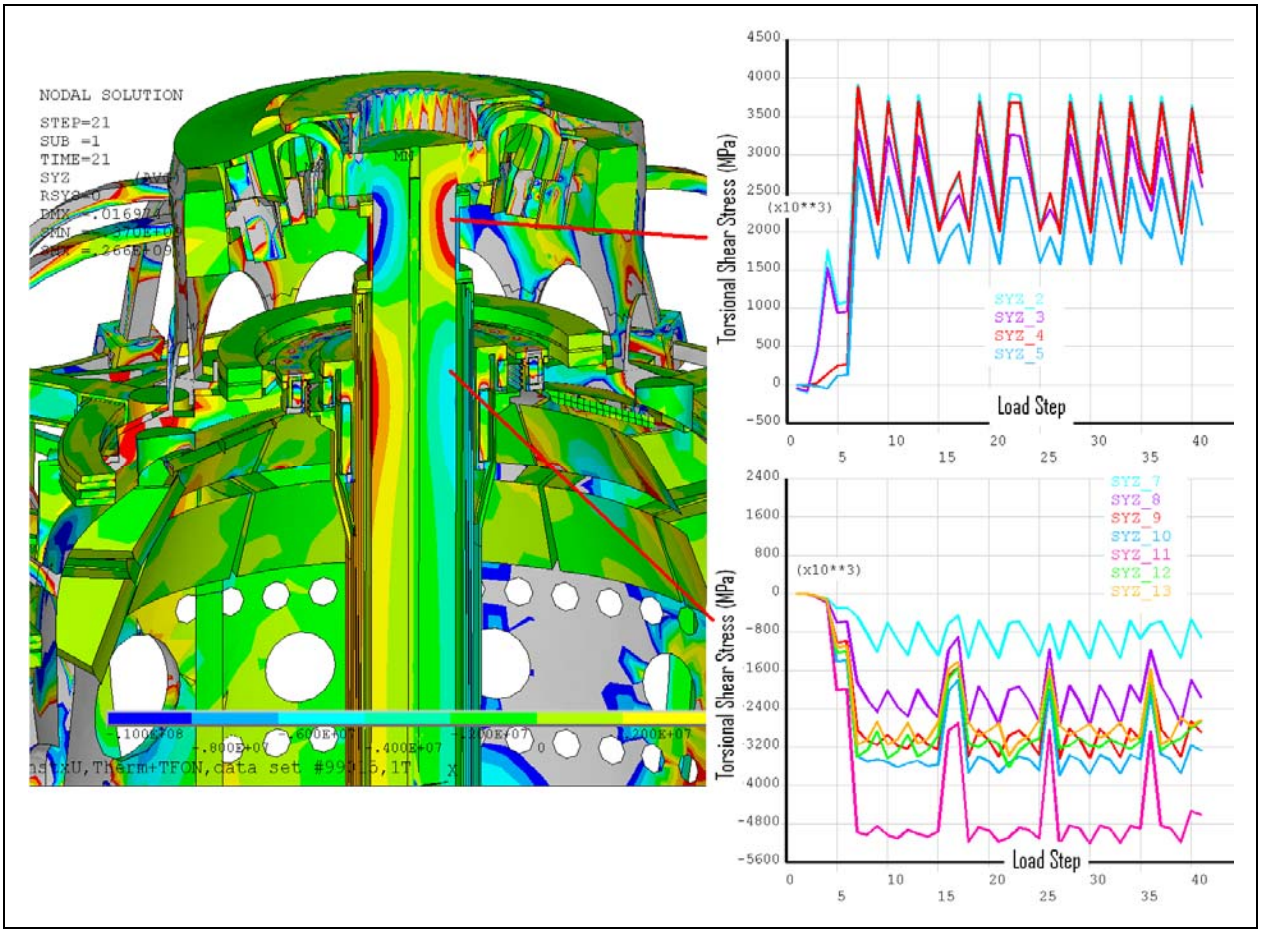

ELEMENTS
(x10**5)
Stress Intensity, MPa
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
TIME
POST26
SINT_1
SINT_4
SINT_5
SINT_6
SINT_7
SINT_8
SINT_9
SINT_10

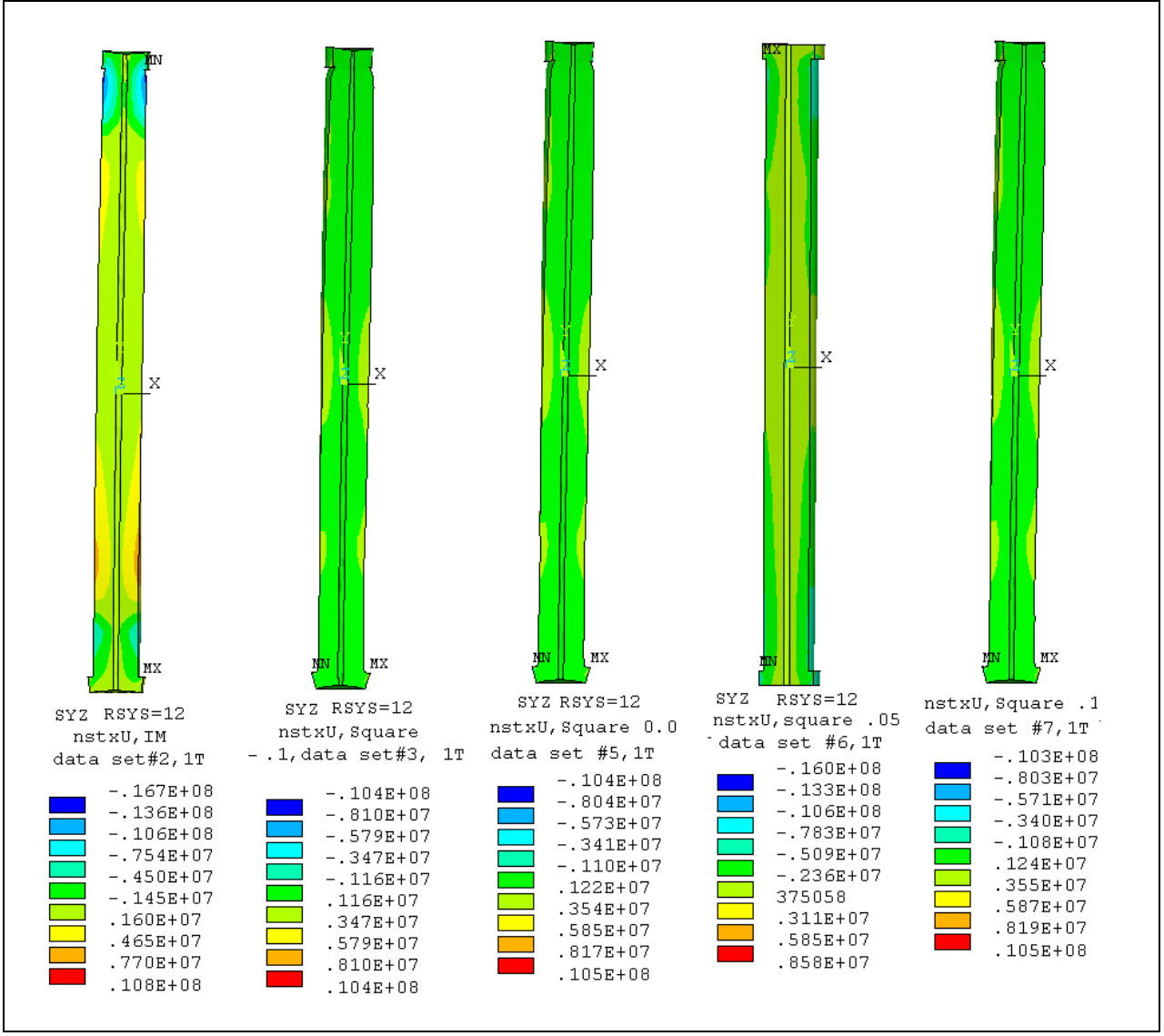

EMENTS
SYZ_2 averaged 236753 YZ Shear
SXZ_3 averaged 40554 XZ Shear
TF Outer Leg Bending Shear
at Bond Plane
(Only First 40 Scenarios)
(x10**3)
6250
5000
3750
2500
1250
0
-1250
-2500
-3750
-5000
-6250
0
5
10
15
20
25
30
35
40
TIME
SYZ_2
SXZ_3
SXZ_4
SYZ_5
SXZ_4 averaged 40573 XZ Shear
SYZ_5 averaged 40573 YZ Shear
Vector Sum = (3.75^2+5^2)^.5 = 6.25 MPa



Toroidal Displacements at the Flex Joint

Center Stack – TF Inner Leg Torsional Shear, Global Model Results



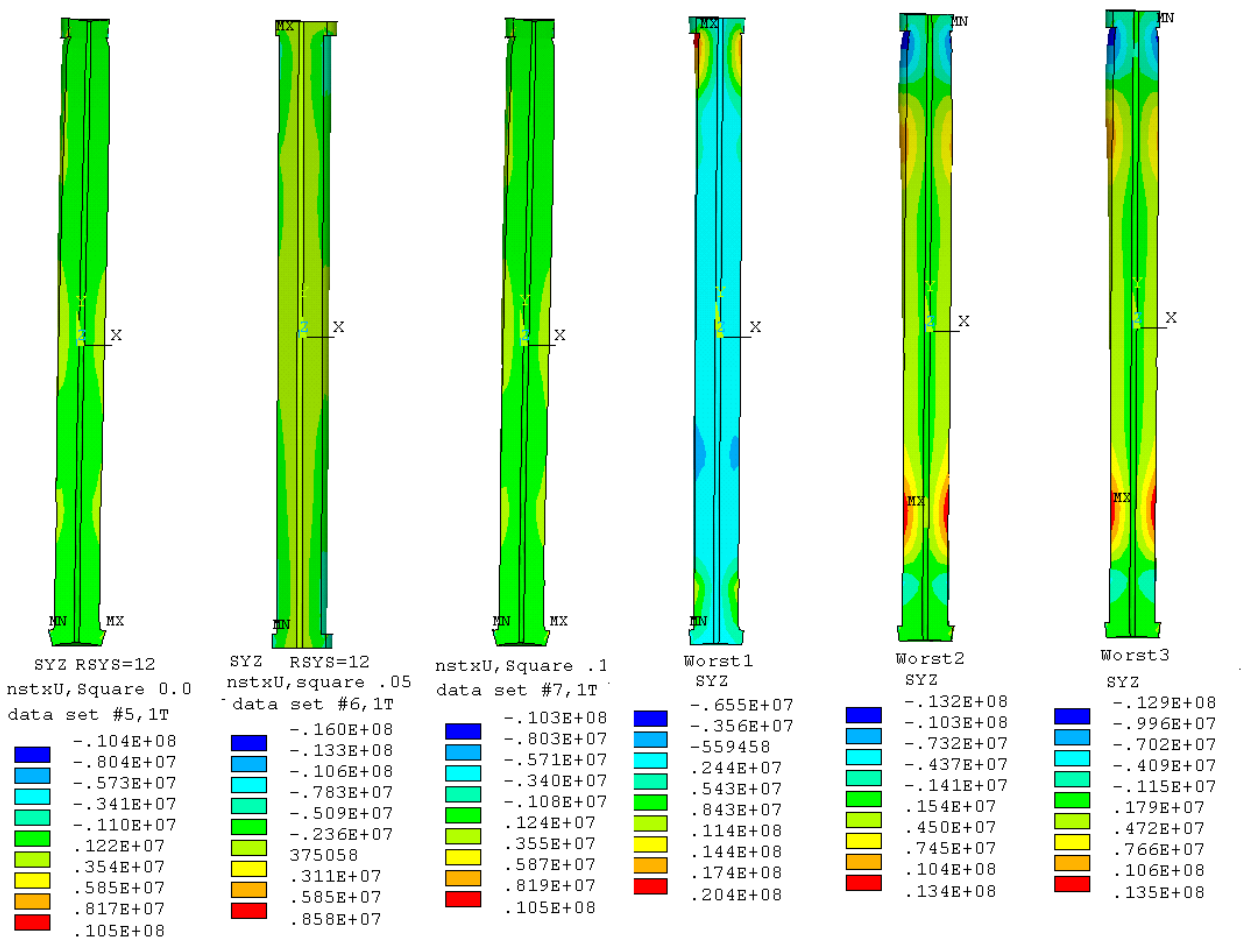


Maximum TF Torsional Shear

Your moment calculations are elegant and will be useful to find the maximums in Charlie's spreadsheet –

The summation of the outer leg moment is directly useful in evaluations of the up-down asymmetric case that Han is running in the diamond truss/tangential - radius rod calculations.

An upper half vs. lower half of the outer legs would be useful in that those loads are either to be equilibrated through the diamond truss or the tangential radius rods and vessel.



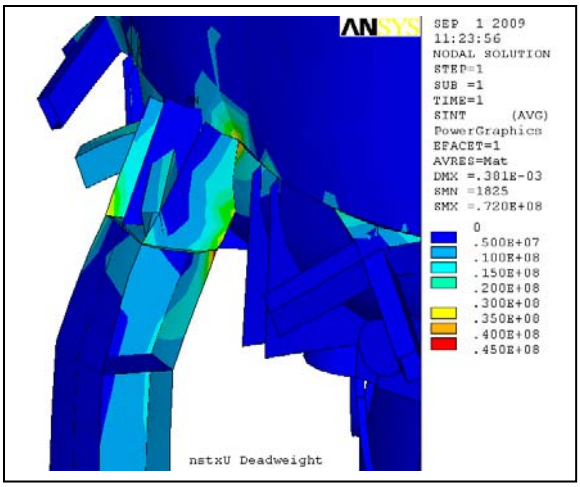
Torsional Shear

TF Outer Leg Connection

The main beam gusset plates are 1.5 inches thick . Visually scaling the welds, they are about 2 inches long and maybe 3/8 fillets.

Joe indicate that the weld seem to about 3/8", definitely less than ½ " and more than ¼ ".
He will measure to confirm.
I will ask Jim about the drawings instructions.

There are 3 on each outside edge and 3 inside- maybe more on the underside



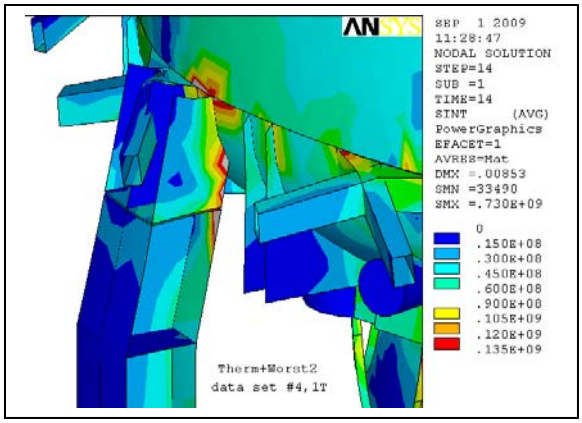
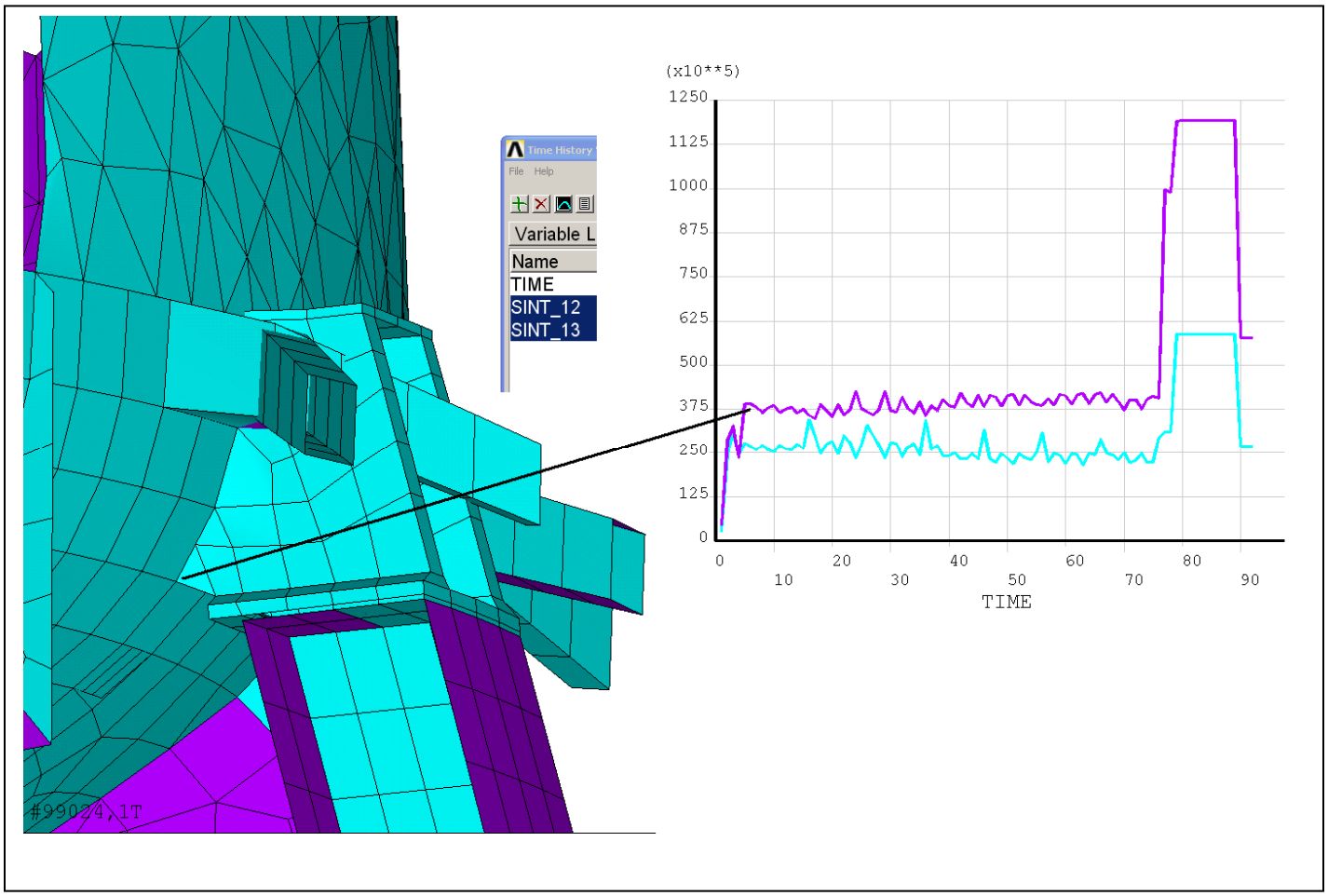
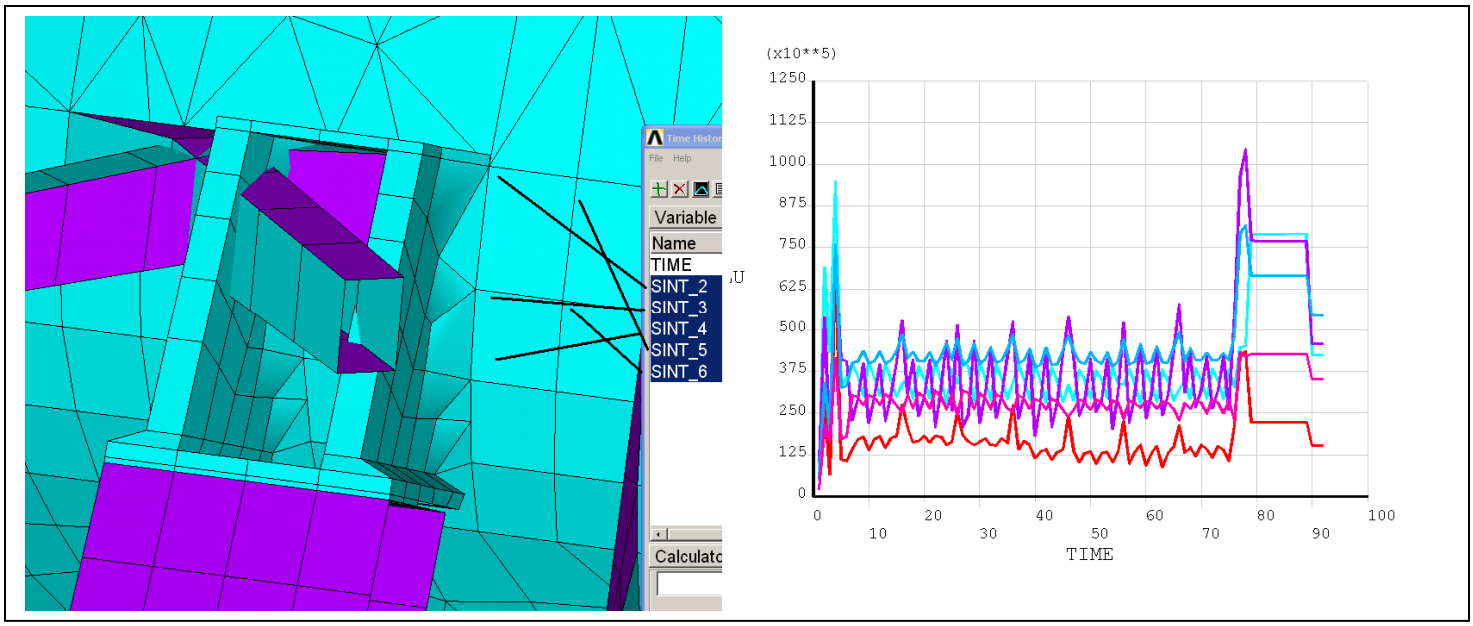
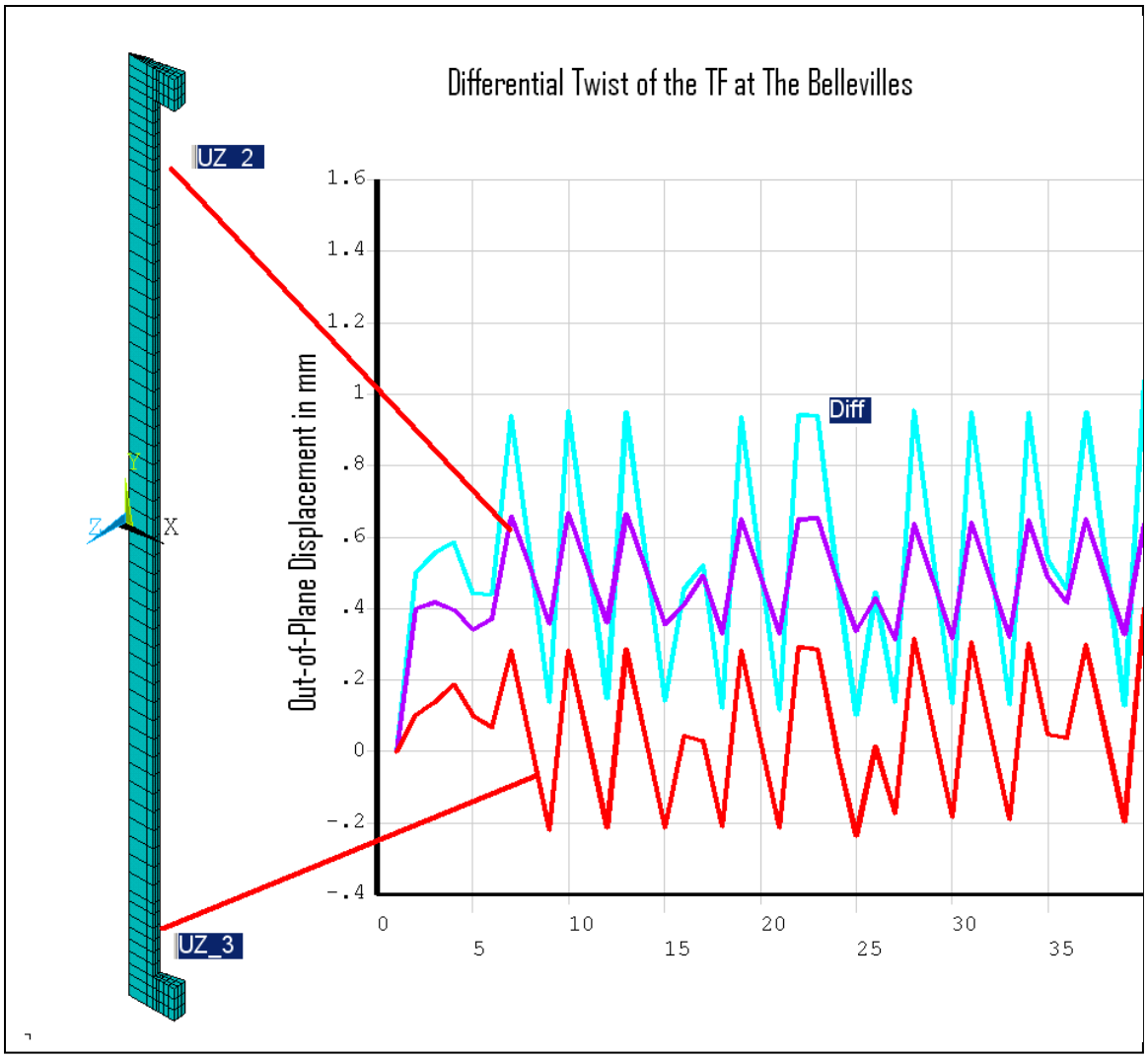


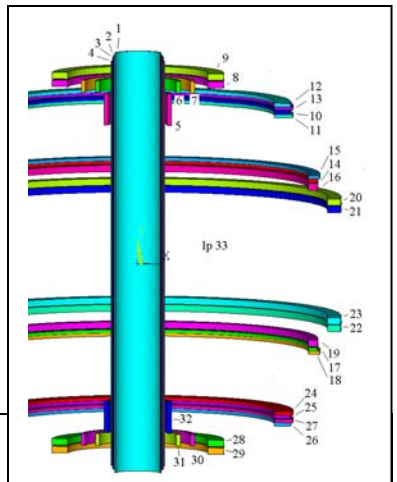
Figure 1.2.3.1-1 Bay B-C

Figure 1.2.3.1-2

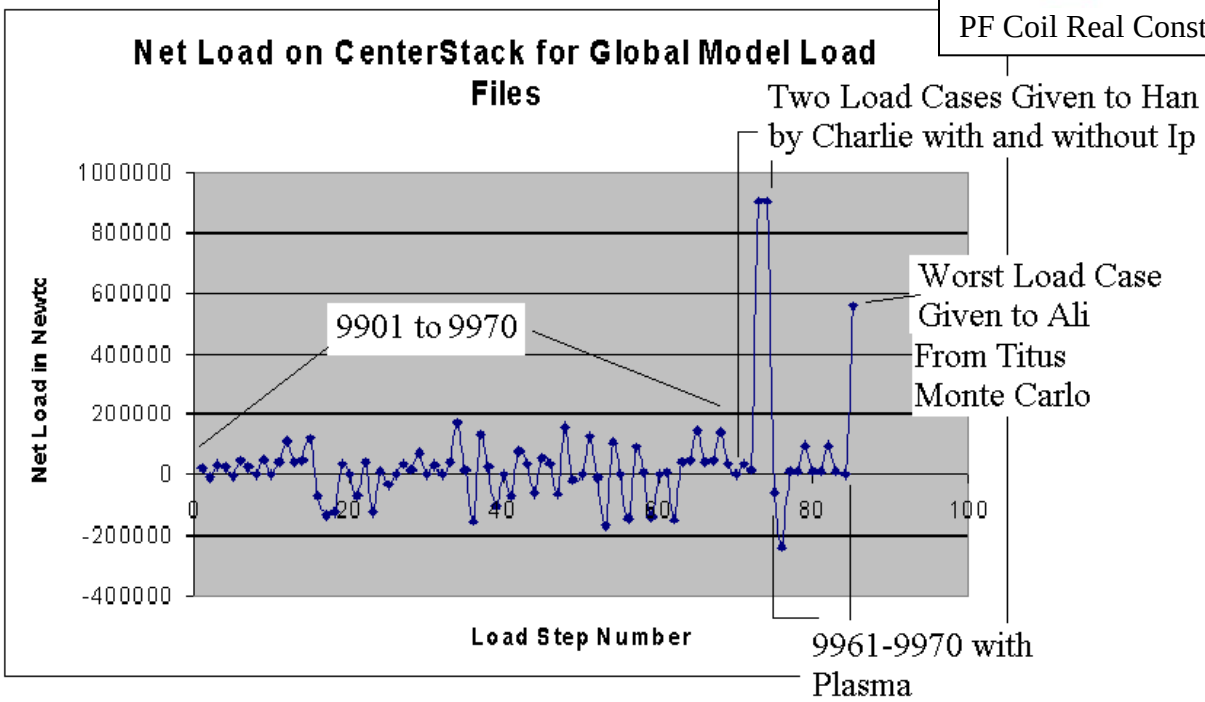

Time History
File Help
Variable L
Name
TIME
SINT_12
SINT_13
(x10**5)
1250
1125
1000
875
750
625
500
375
250
125
0
0
10
20
30
40
50
60
70
80
90
TIME
#99024,1T

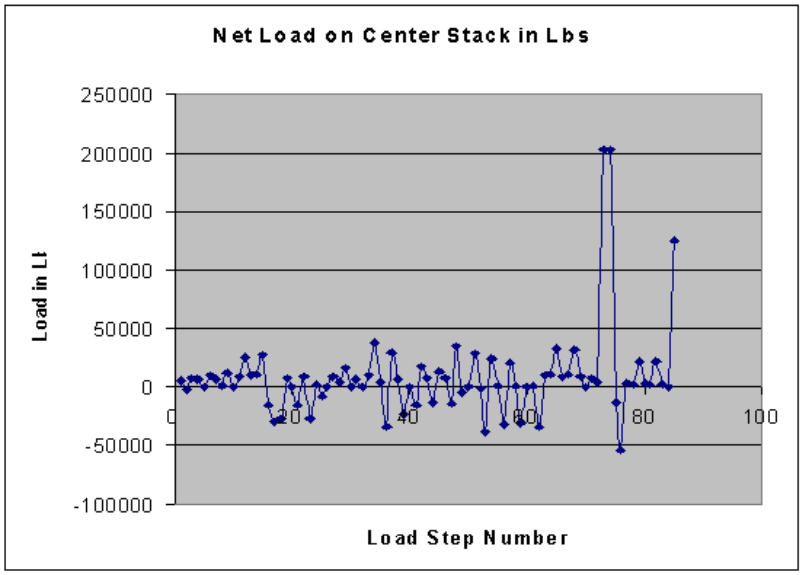

Variable
Name
TIME
SINT_2
SINT_3
SINT_4
SINT_5
SINT_6
Calculatc
(x10**5)
1250
1125
1000
875
750
625
500
375
250
125
0
0
10
20
30
40
50
60
70
80
90
100
TIME

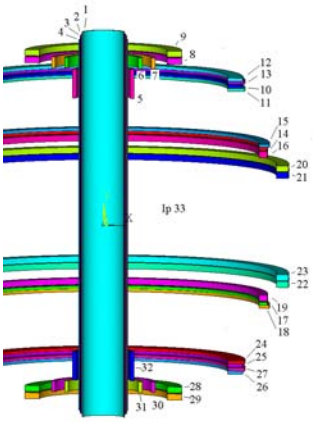

Differential Twist of the TF at The Bellevilles
UZ_2
UZ_3
Diff
Out-of-Plane Displacement in mm
1.6
1.4
1.2
1
.8
.6
.4
.2
0
-.2
-.4
0
5
10
15
20
25
30
35
Y
Z
X



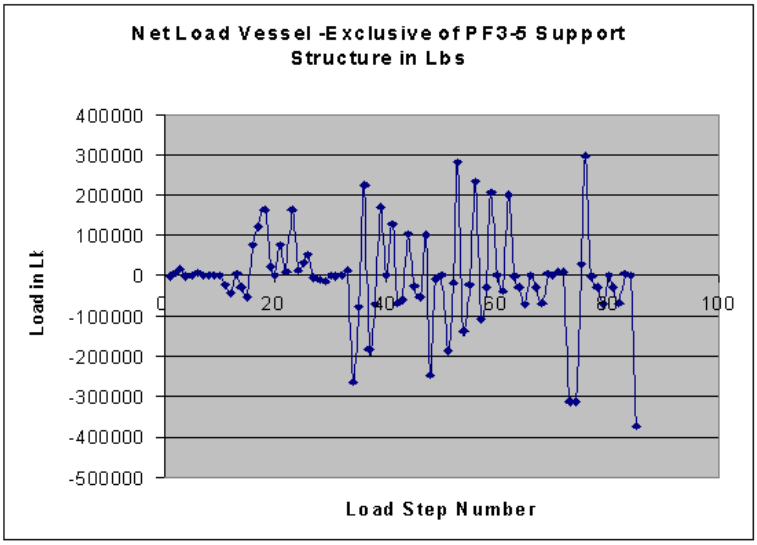
PF Coil Real Constants

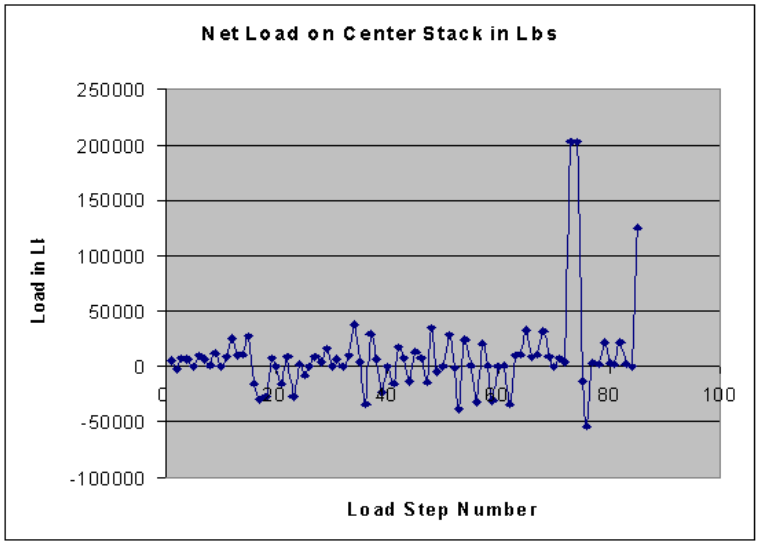




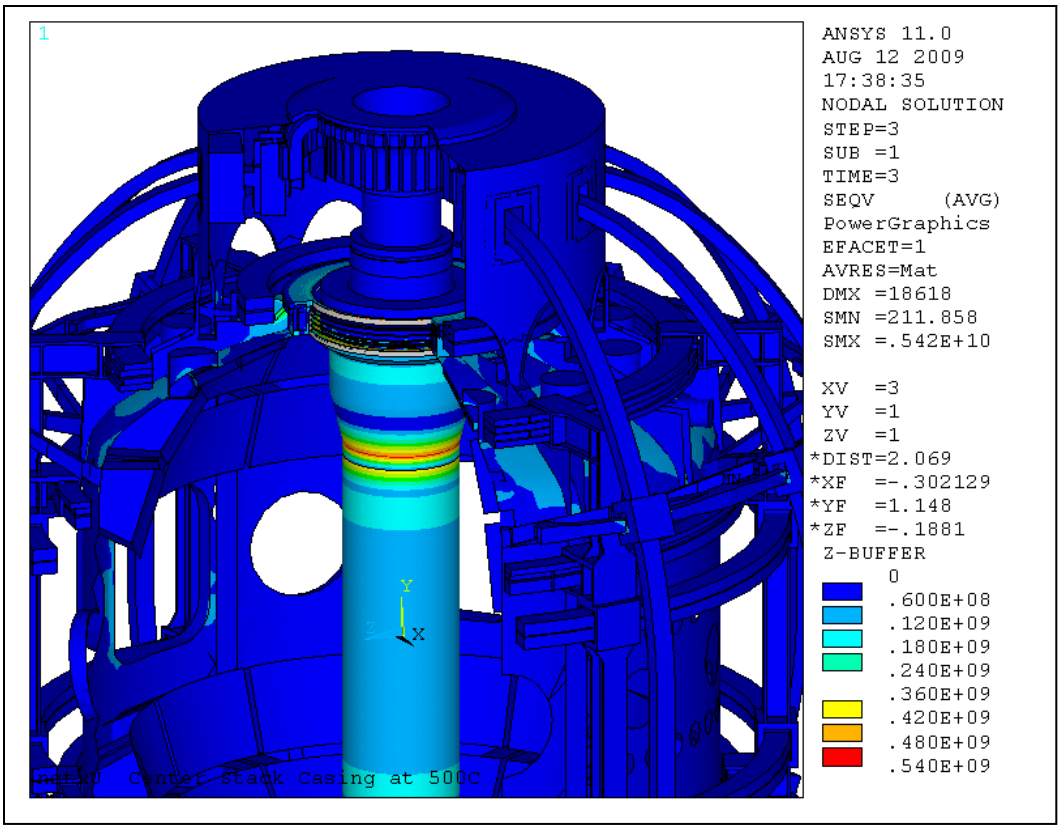


PF Coil Real Constants





Center Stack Casing Thermal Stress

- 500C During Plasma Operation Ref: Art Brooks Original Calculation
- Yield of 625 at 600C is 410 MPa
- From Len's Presentation:
- For good fatigue resistance the peak stresses in the Incoloy structure should be kept below ~380 MPa.

540MPa for 500C Plasma Operation and 400MPa for 350C Bake-Out