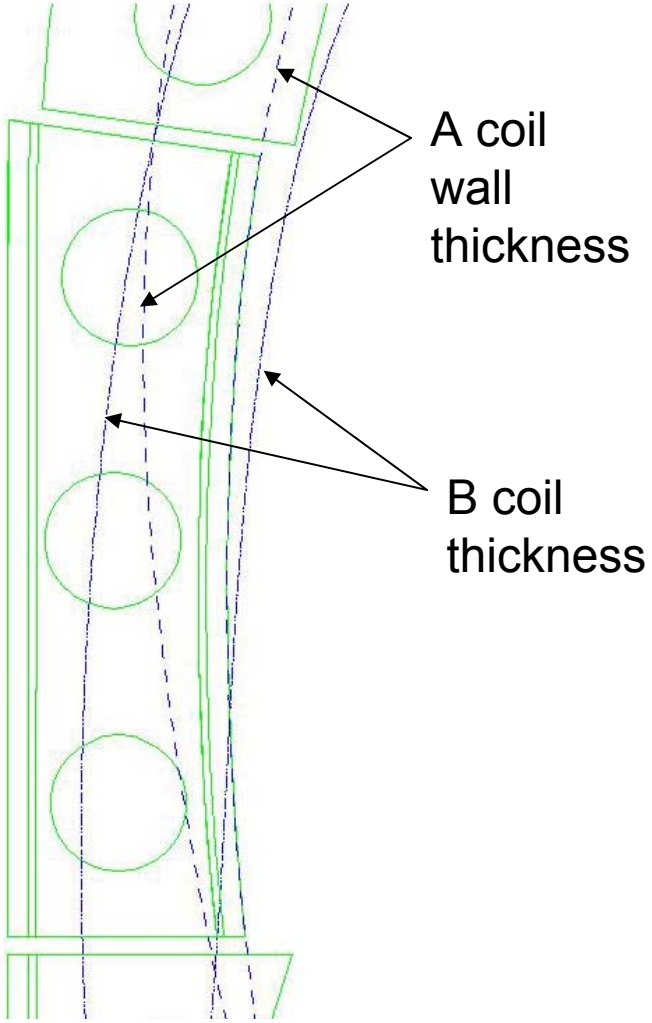
Modified AB-2 SHEAR PLATE Record of Design Change

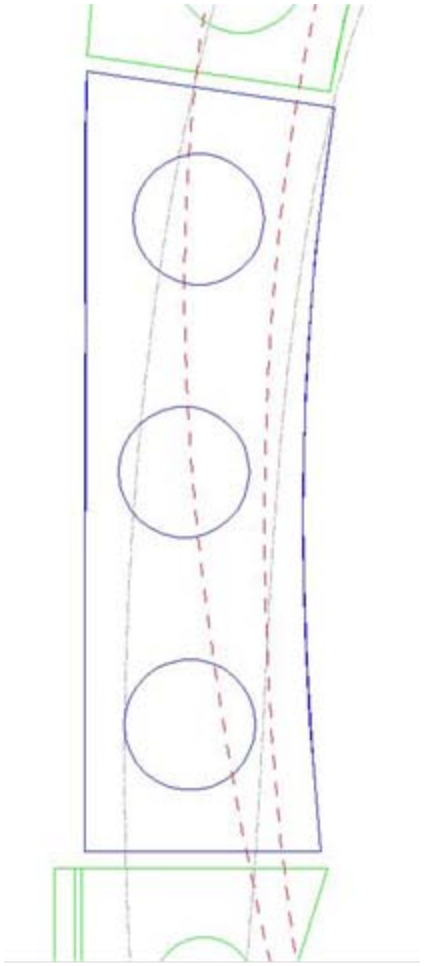
03/25/2008
Compiled by: P. Heitzenroeder
Analyses by: K. Freudenberg
Design details by: G. McGinnis
Reviewed by: M. Zarnstorff

Background

- Mike Viola requested that the weld for plate AB-2 be changed to a J prep type to improve welding (ie, avoid weld drop-out in open overhead welds in former overhanging fillet configuration).
- The revised plate is narrower, decreasing margin to puck holes.
- Originally a 4 hole, 1.5”puck diameter was planned to address hole margin,and dxf files were made of this.
- A shop mis-communication resulted in a modified 3-hole shim plate being manufactured.
- It was decided to perform stress analyses to determine if this modified 3 hole plate could be used.
- Analyses indicated this design is as good as the 4 hole, and consequently was adopted. ***This document shall serve as the document of record of that change.***

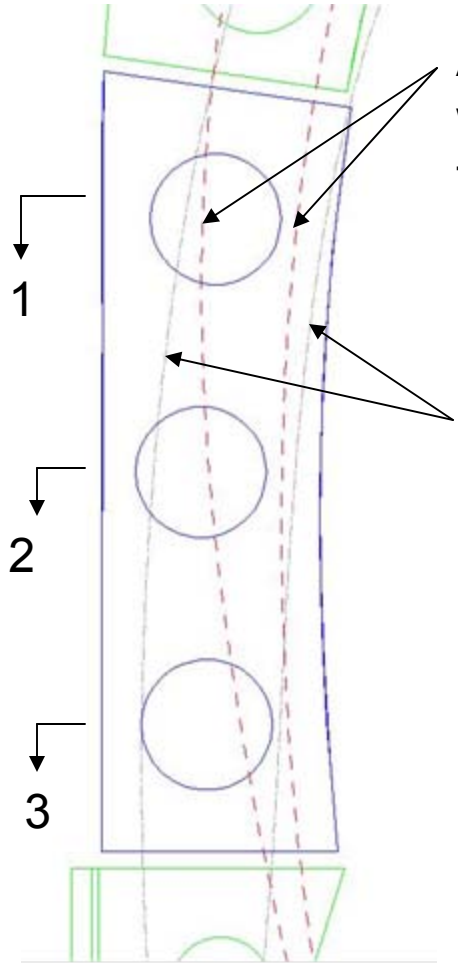
Actual puck shift is .44” outward



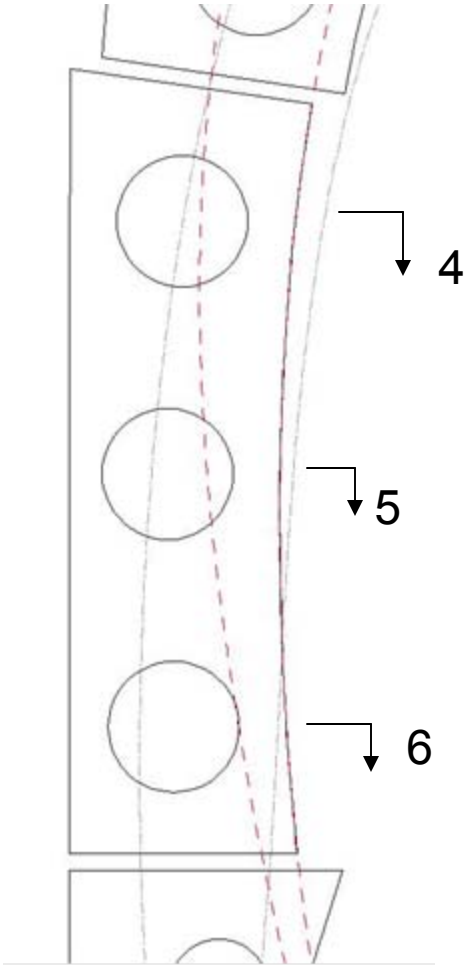


New 3 Puck from PPPL (with J weld preps)

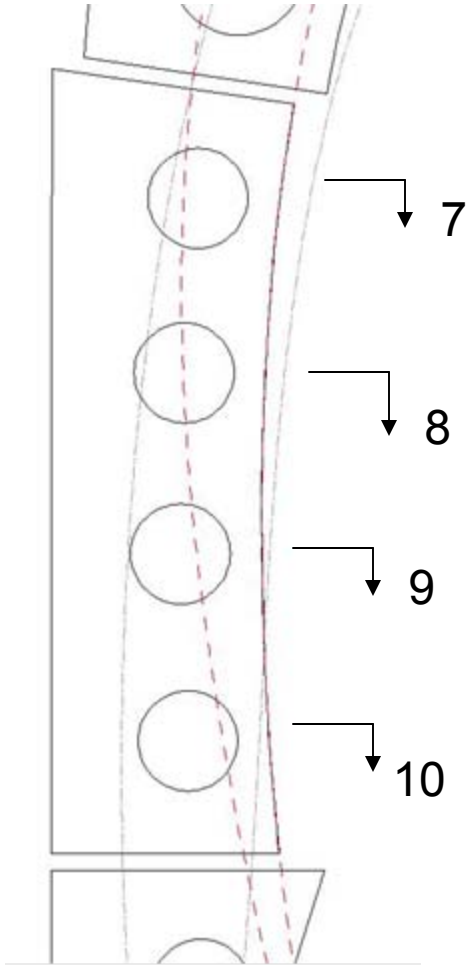
Original 3 Puck



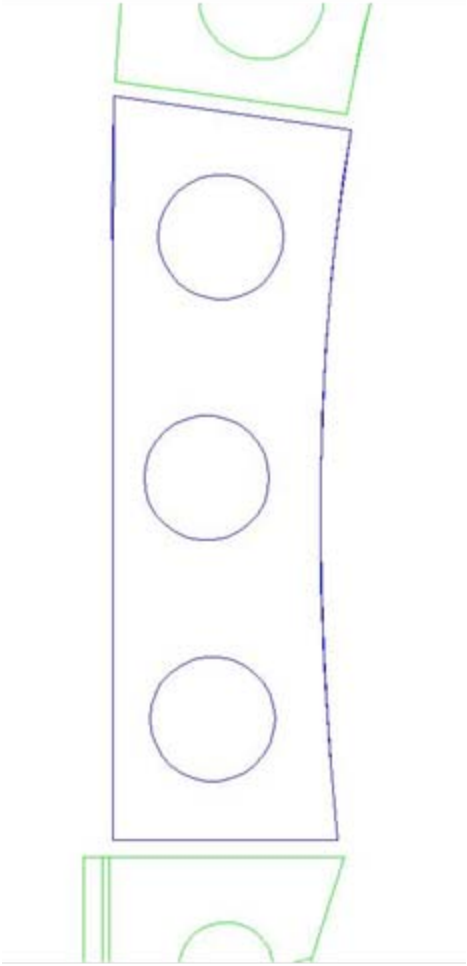
Current Plate



Current Plate Shifted ½" -Pucks shift also. ***This is the new design.*** Note that the casting wall as shown is nominal – actual wall thickness is greater due to overcast.



Shifted Plate with 4 Pucks -Current Puck CL



Current Plate

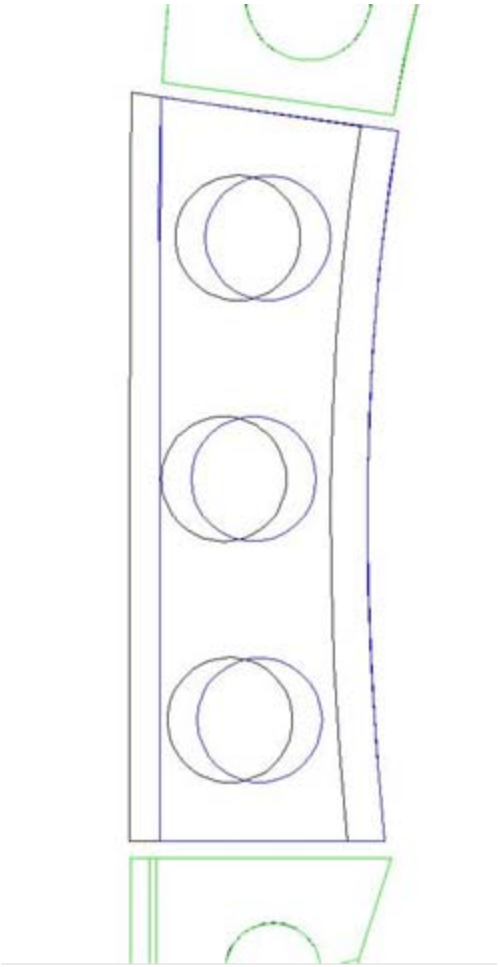


Plate shifted ½” overlaid on current

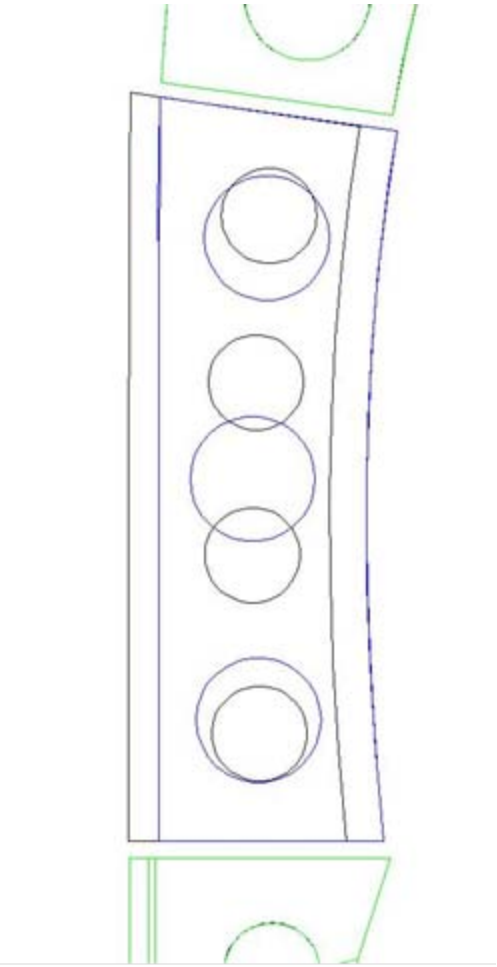
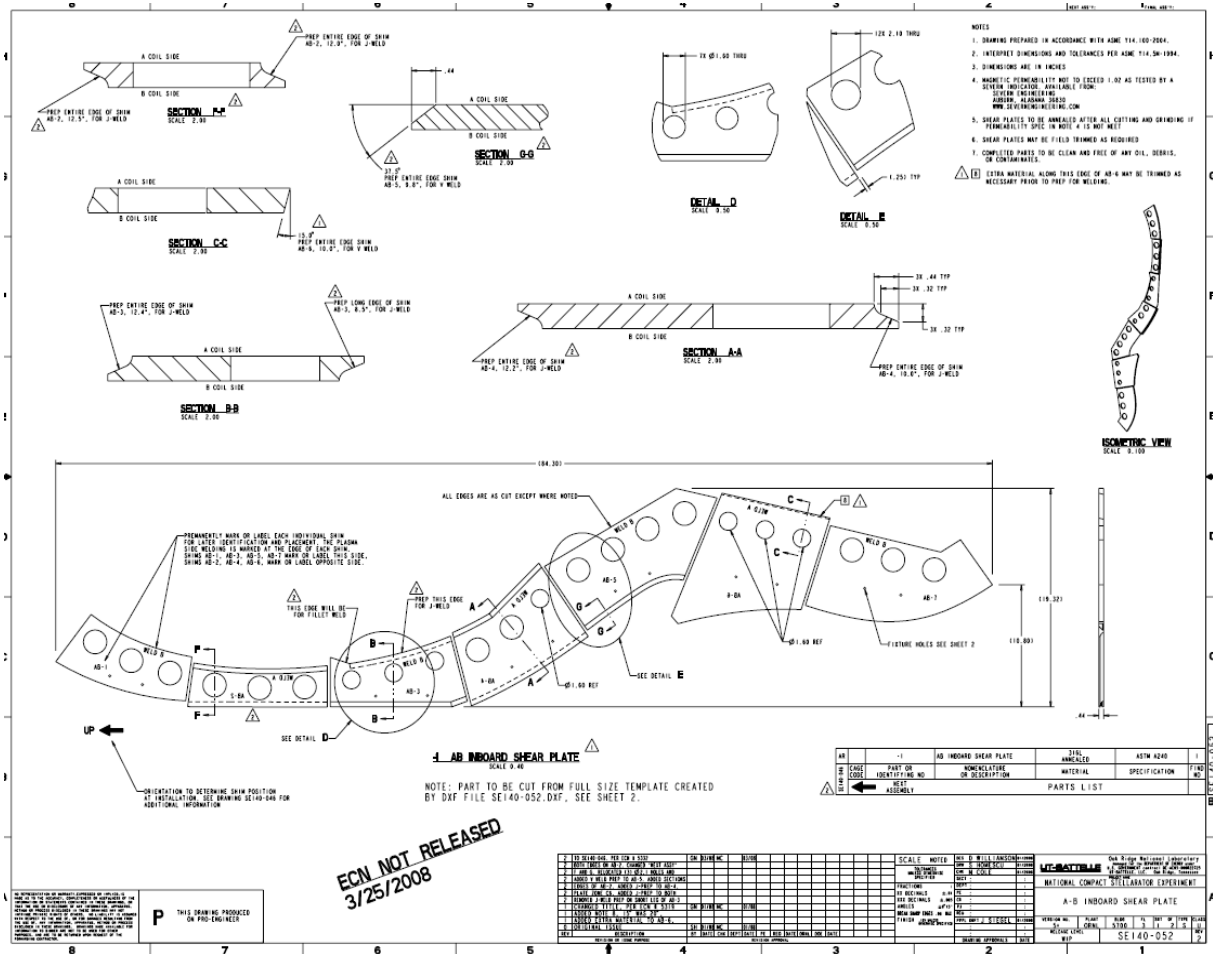
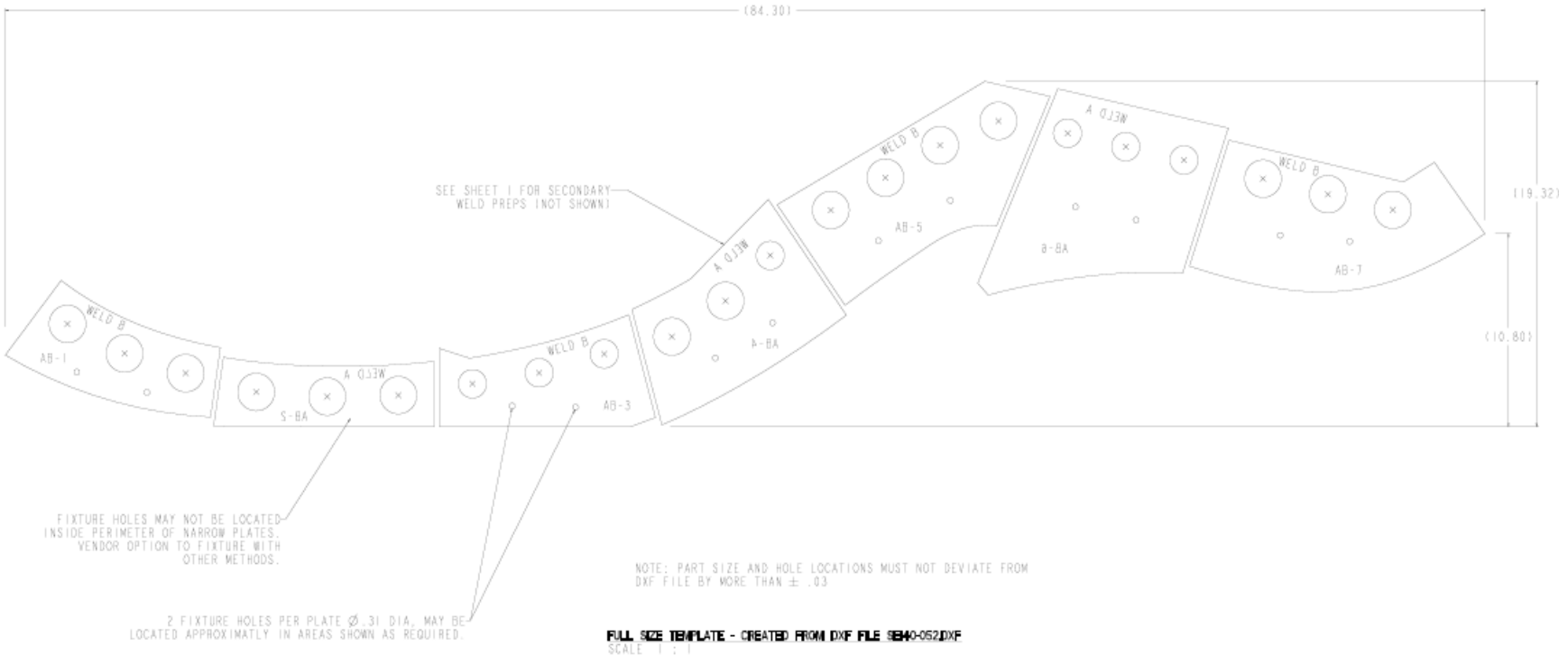


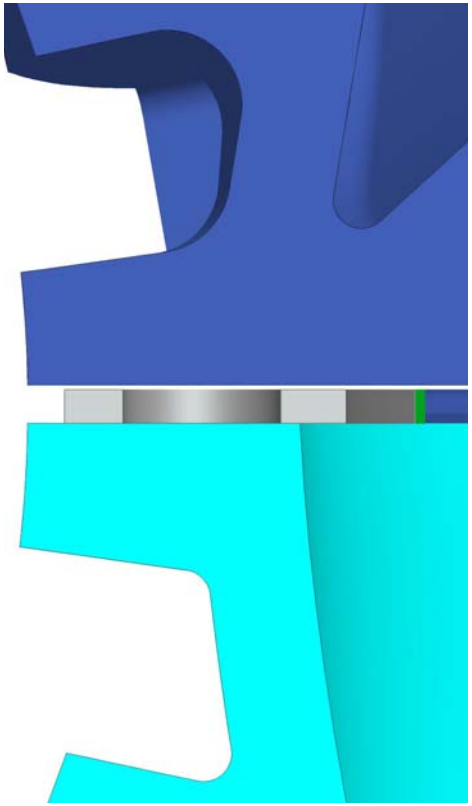
Plate shifted with 4 smaller pucks overlaid on current

AB shear plates

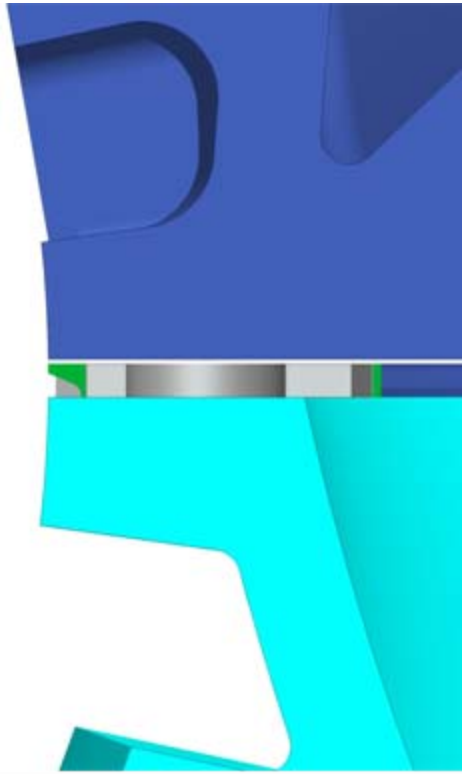


AB Template

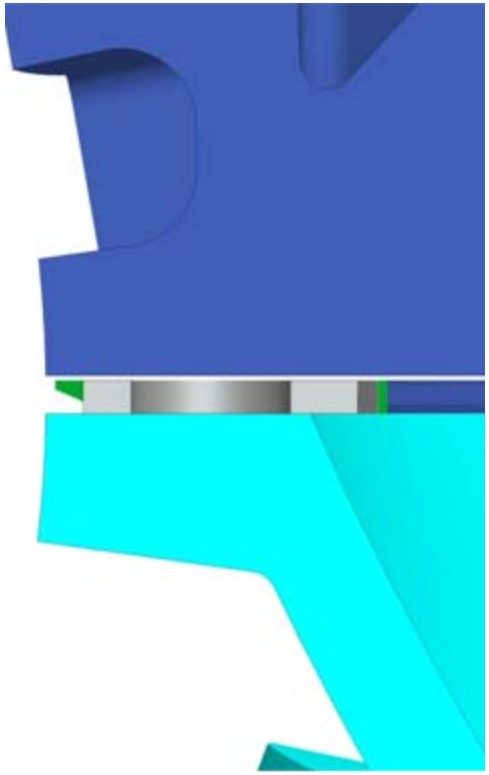

(84.30)
(19.32)
(10.80)
SEE SHEET 1 FOR SECONDARY WELD PREPS (NOT SHOWN)
WELD B
AB-1
WELD A
S-BA
WELD B
AB-3
WELD A
A-BA
WELD B
AB-5
WELD A
a-BA
WELD B
AB-7
FIXTURE HOLES MAY NOT BE LOCATED INSIDE PERIMETER OF NARROW PLATES. VENDOR OPTION TO FIXTURE WITH OTHER METHODS.
2 FIXTURE HOLES PER PLATE Ø.31 DIA, MAY BE LOCATED APPROXIMATLY IN AREAS SHOWN AS REQUIRED.
NOTE: PART SIZE AND HOLE LOCATIONS MUST NOT DEVIATE FROM DXF FILE BY MORE THAN ± .03
FULL SIZE TEMPLATE - CREATED FROM DXF FILE SB40-052.DXF
SCALE 1 : 1



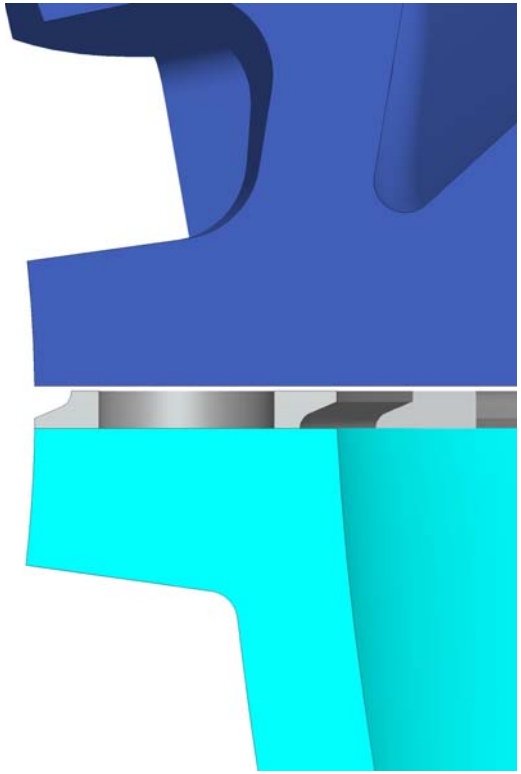
Section 1



Section 2



Section 3



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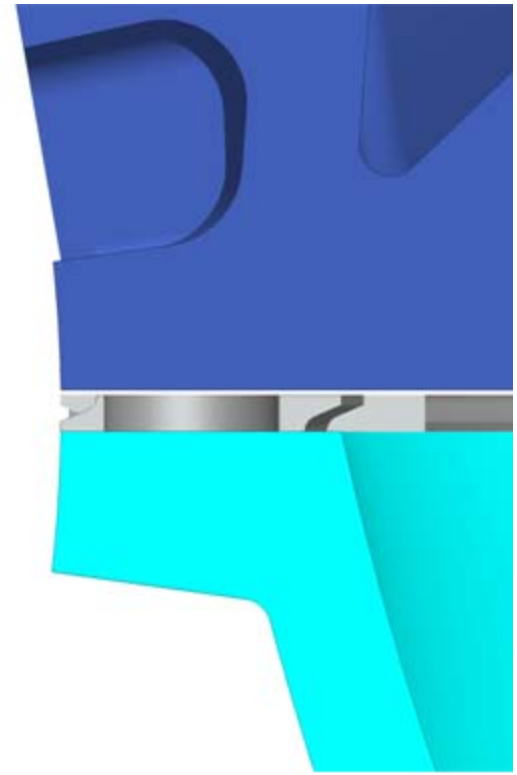
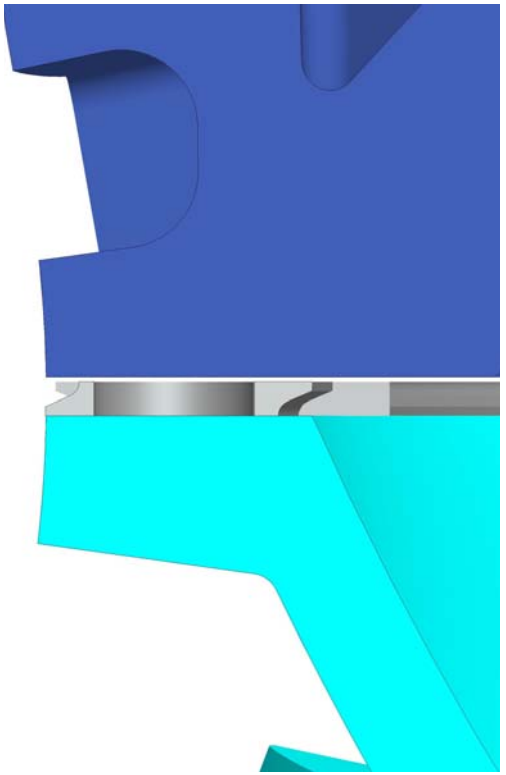
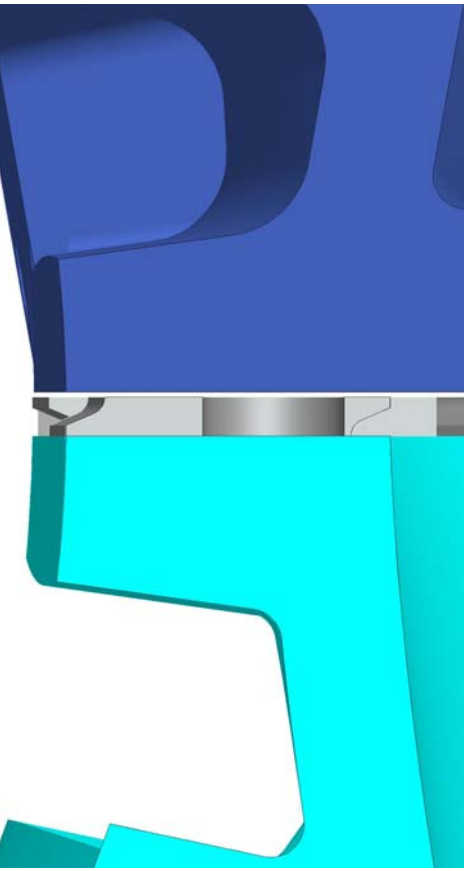


Section 5



Section 6



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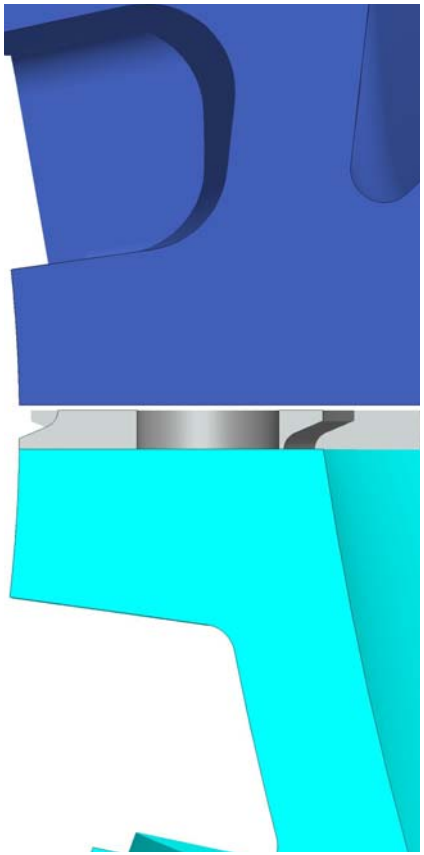
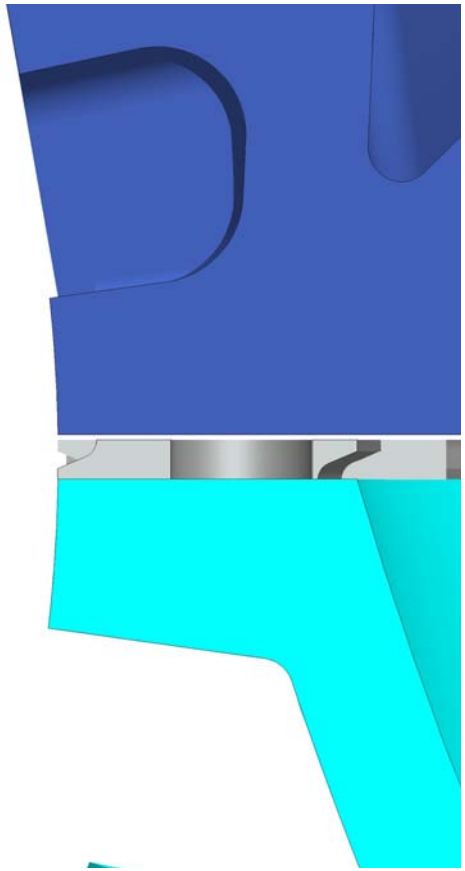
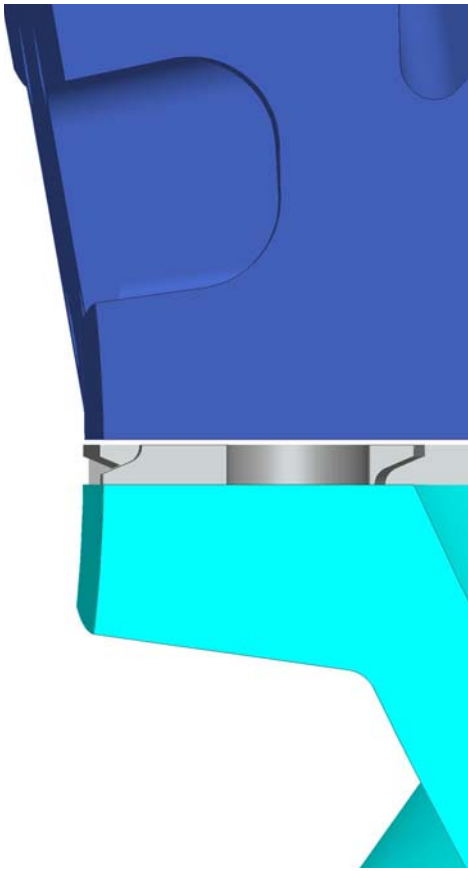


Section 8



Section 9



Section 10

Summary of Stress Analysis of 3/24/2008 (see following slides for ANSYS plots)

- From Kevin's e-mail of 3/25/08:

- Stress on pucks does go up to 27.7 ksi vs 26.7 with 4 pucks
- peak weld stress now at 36.6 ksi down from 38.4 ksi (same node at corner)
- peak shim stress now at 44.5 ksi down slightly from 4 (same corner node)
- Bottom line,
- three hole as good as four puck concept, original overhead weld was better.
- Kevin
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- Kevin D. Freudenberg
- Mechanical Design and Analysis
- Oak Ridge National Laboratory
- US ITER Team
- (865) 574-1310
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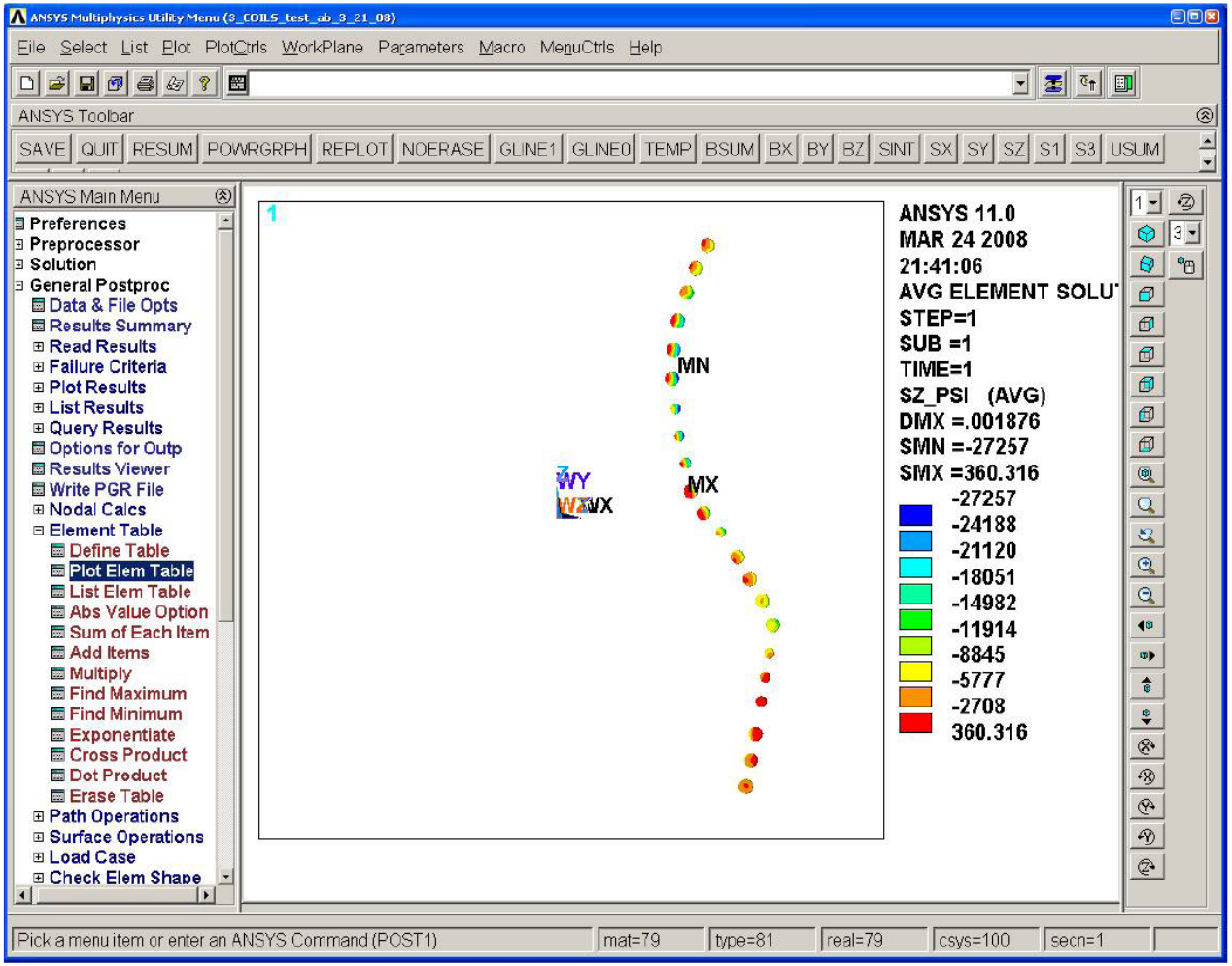
From: Freudenberg, Kevin D.
To: Mike Cole; Phil Heitzenroeder; Gary McGinnis;
Subject: stress images for three hole concept
Date: Monday, March 24, 2008 9:49:03 PM

Stress on pucks does go up to 27.7 ksi vs 26.7 with 4 pucks
peak weld stress now at 36.6 ksi down from 38.4 ksi (same node at corner)
peak shim stress now at 44.5 ksi down slightly from 4 (same corner node)

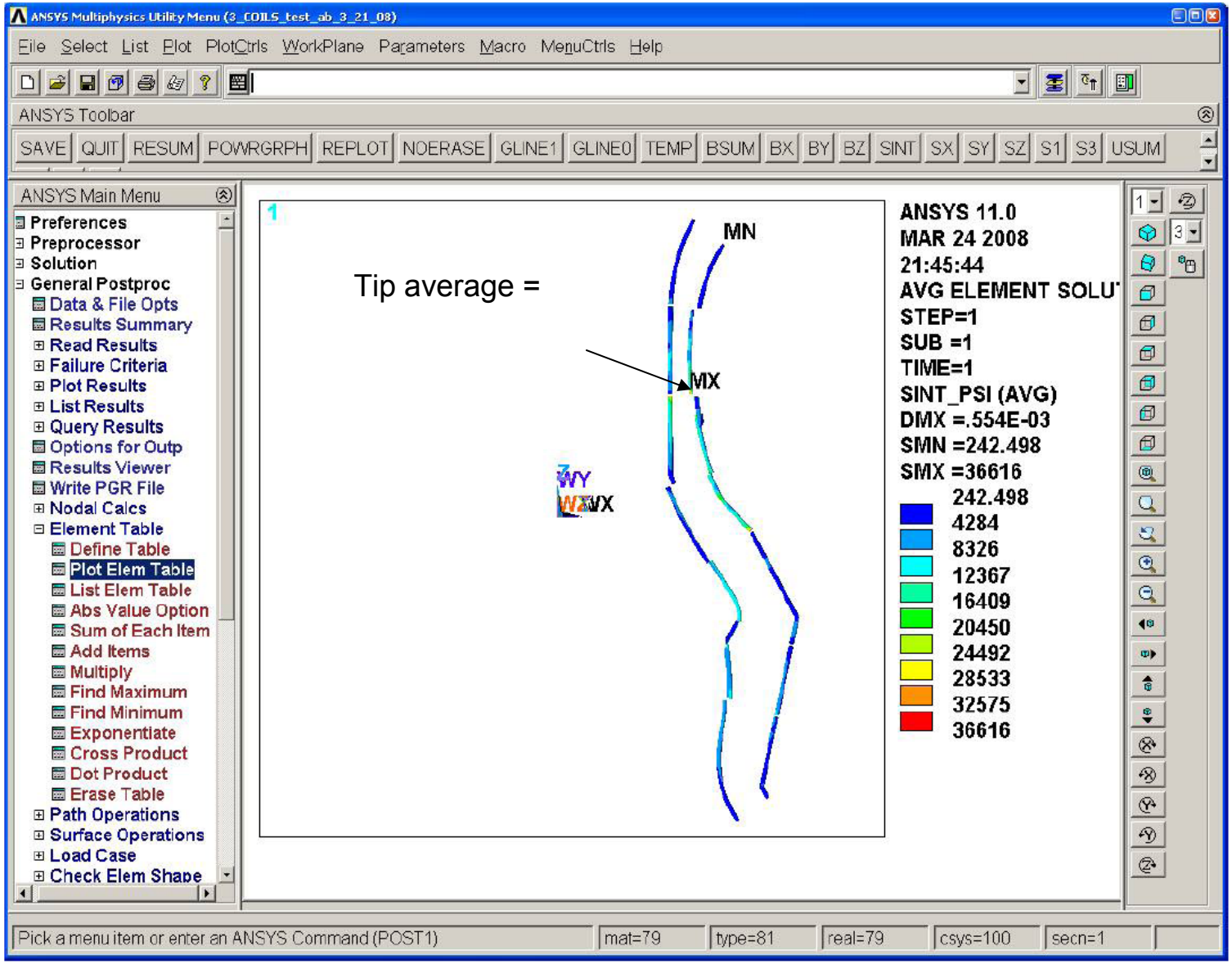
Bottom line,

three hole as good as four puck concept, original overhead weld was better.

Kevin

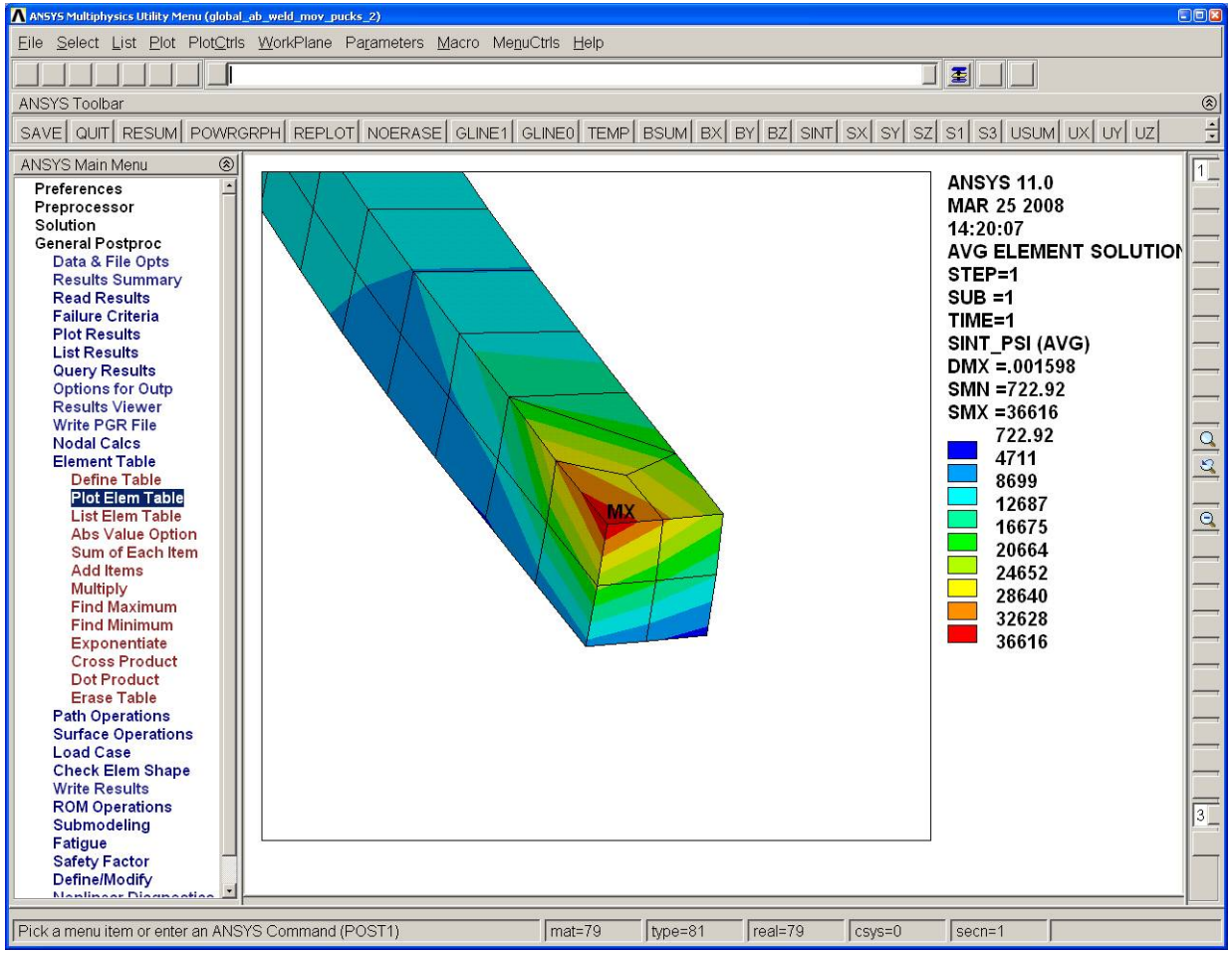


Weld stress, modified 3 puck AB-2

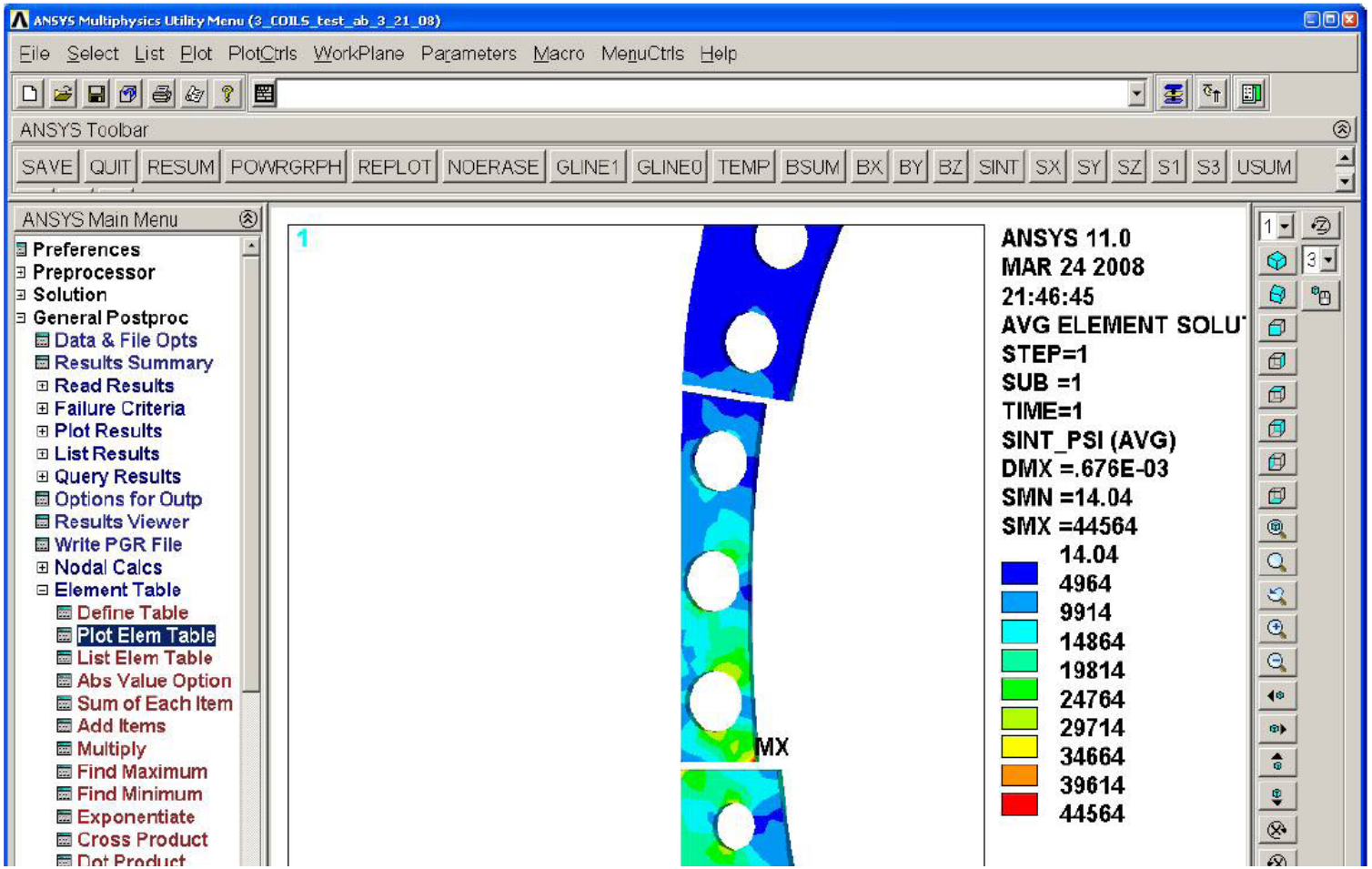


- Modeled as Square welds, ½ x ½”.

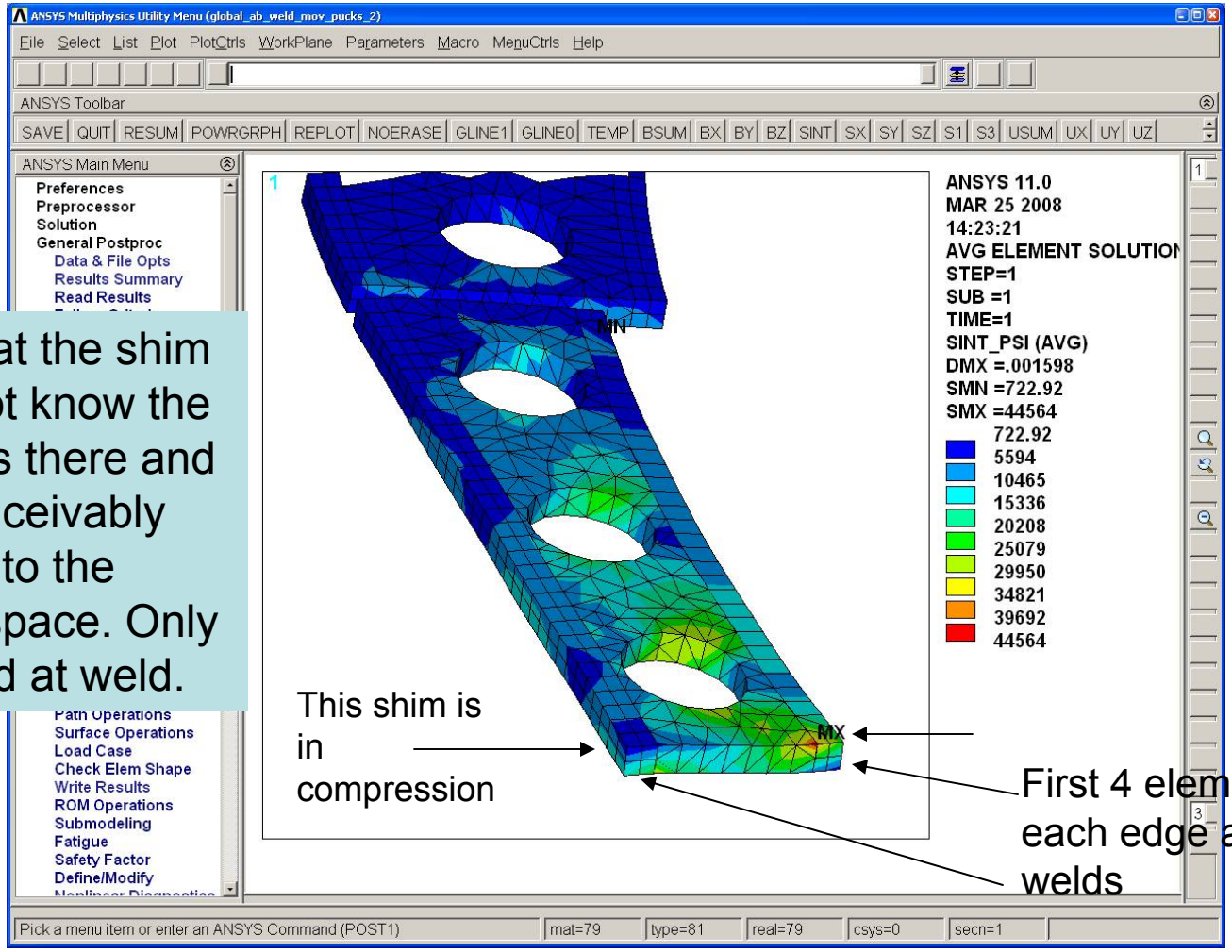
Close up view of weld



Shear plate stress, modified AB-2

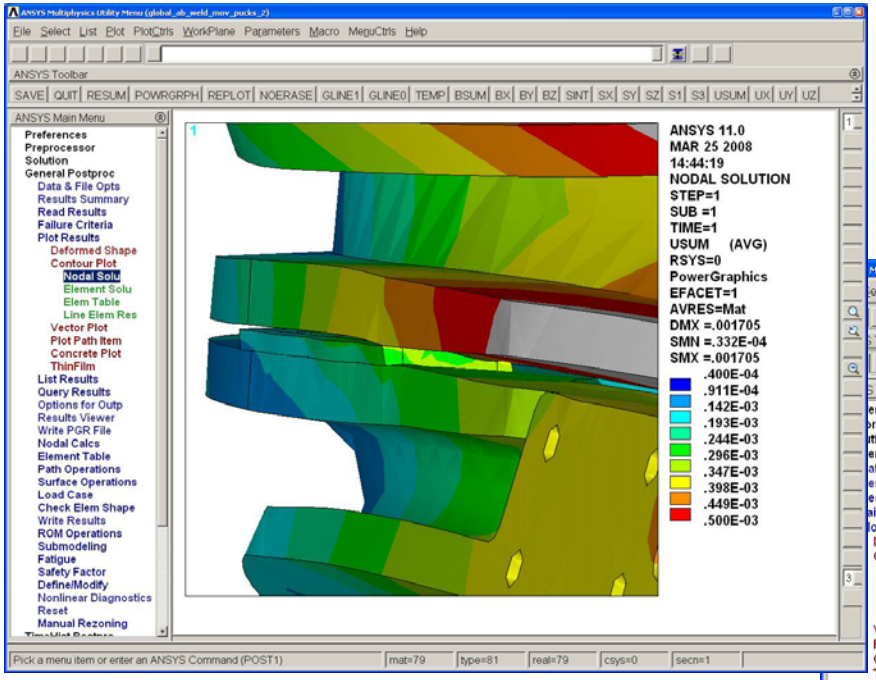


Close up view of shim

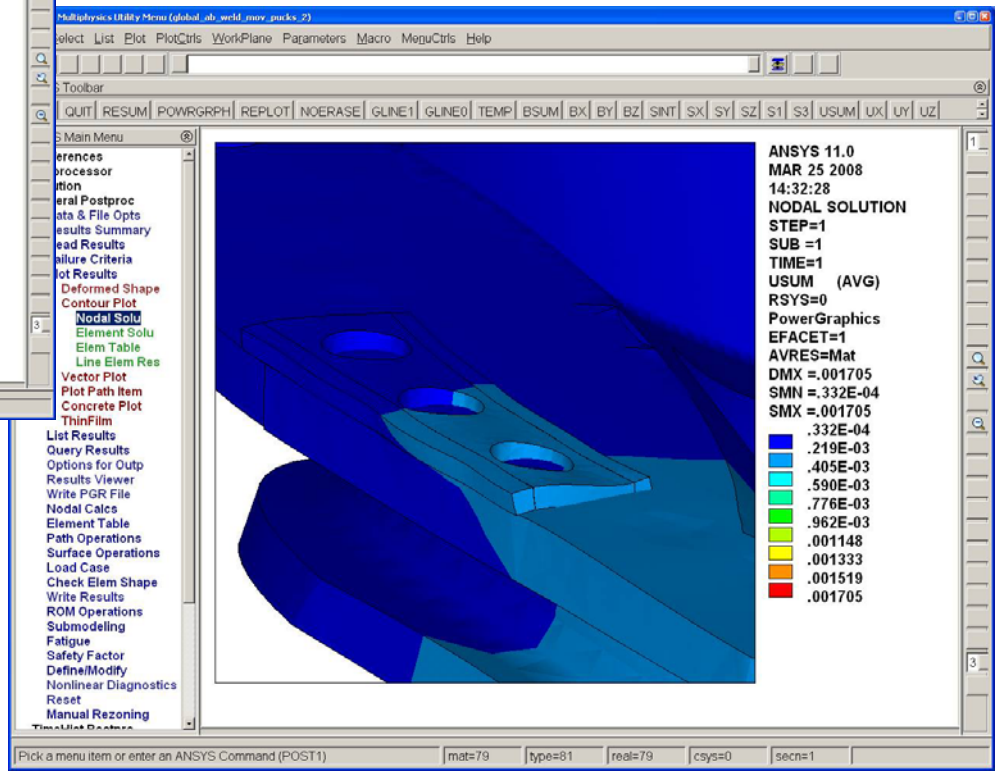


Note that the shim does not know the flange is there and can conceivably move into the flange space. Only attached at weld.

These slides shows shim bending & fictitious shim motion into flange (85X defl.)



Defl. In mm



Stellalloy Properties

Casting Comparison	77K (-320F)							293K (RT)						
Property	**Required**	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**Required**	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**
Elastic Modulus	21 Msi (144.8 Gpa)	23.3	25.5	24.9	26.5	30.2	28.8	20 Msi (137.9 Gpa)	23.1	22.7	21.6	23.1	27.3	24.1
0.2% Yield Strength	72 ksi (496.4 Mpa)	98.4	93.2	97.1	97.8	102.5	99.5	34 ksi (234.4 Mpa)	35.1	36.6	38.3	37.4	38.8	44.5
Tensile Strength	95 ksi (655 Mpa)	170.3	163.8	163.1	164.8	170.9	159.9	78 ksi (537.8 Mpa)	83.7	82.4	82.7	83.1	87.0	83.7
Elongation	32.0%	55.7%	54.3%	55.7%	54.0%	42.4%	42.3%	36.0%	52.0%	53.5%	52.5%	55.7%	58.0%	40.3%
Charpy V – notch Energy	35 ft. lbs. (47.4 J)	77.7	84.3	99.7	86.7	80.3	85.3	50 ft-lbs (67.8 J)	142.0	150.7	157.3	175.7	139.0	152.3

Type A

Casting Comparison	77K (-320F)							293K (RT)						
Property	**Required**	**A-1**	**A-2**	**A-3**	**A-4**	**A-5**	**A-6**	**Required**	**A-1**	**A-2**	**A-3**	**A-4**	**A-5**	**A-6**
Elastic Modulus	21 Msi (144.8 Gpa)	25.5	25.3	26.7	28.9	26.4	27.9	20 Msi (137.9 Gpa)	21.7	22.2	21.9	22.9	23.1	22.6
0.2% Yield Strength	72 ksi (496.4 Mpa)	97.3	99.9	98.9	100.0	101.0	103.2	34 ksi (234.4 Mpa)	36.6	43.3	43.2	43.8	42.4	44.5
Tensile Strength	95 ksi (655 Mpa)	166.3	165.3	166.0	165.9	165.2	163.0	78 ksi (537.8 Mpa)	82.4	83.7	82.6	84.6	82.2	89.2
Elongation	32.0%	56.0%	56.3%	51.0%	46.0%	48.7%	38.3%	36.0%	53.2%	56.0%	53.3%	50.3%	50.0%	49.0%
Charpy V – notch Energy	35 ft. lbs. (47.4 J)	78.7	79.0	87.3	76.7	70.3	73.0	50 ft-lbs (67.8 J)	163.7	164.0	158.0	150.3	146.3	126.7

Type B

Casting Comparison	77K (-320F)							293K (RT)						
Property	**Required**	**B-1**	**B-2**	**B-3**	**B-4**	**B-5**	**B-6**	**Required**	**B-1**	**B-2**	**B-3**	**B-4**	**B-5**	**B-6**
Elastic Modulus	21 Msi (144.8 Gpa)	25.9	27.4	29.3	25.3	29.3		20 Msi (137.9 Gpa)	22.7	22.5	22.6	22.8	22.6	
0.2% Yield Strength	72 ksi (496.4 Mpa)	98.7	103.9	107.4	100.2	107.4		34 ksi (234.4 Mpa)	43.3	58.9	42.7	42.6	42.7	
Tensile Strength	95 ksi (655 Mpa)	164.9	177.5	172.5	166.1	177.5		78 ksi (537.8 Mpa)	86.0	86.6	84.1	85.6	84.1	
Elongation	32.0%	46.3%	50.3%	56.3%	53.3%	56.3%		36.0%	47.3%	49.5%	44.7%	43.5%	44.7%	
Charpy V – notch Energy	35 ft. lbs. (47.4 J)	88.0	63.7	74.7	65.7	74.7		50 ft-lbs (67.8 J)	146.7	135.7	115.0	119.7	115.0	

Weld Properties

Weld Material		77K (-320F)						293K (RT)							
Property	**Required**	**Lincoln 3018926/78309**	**Lincoln Lot # 3012668/82743**	**Lincoln 3018513/78308**	**Lincoln Lot # 3017006/72262**	**Metrode Lot # WO21735**	**Metrode Lot # WO19711**	**Required**	**Lincoln 3018926/78309 Doc #10**	**Lincoln Lot # 3012668/82743 see previous info ->**	**Lincoln 3018513/78308**	**Lincoln Lot # 3017006/72262**	**Metrode Lot # WO21735**	**Metrode Lot # WO19711**	**Previously Reported Heat/Lot # 3012668/82743**
Elastic Modulus	21 Msi (144.8 Gpa)	23.3	27.1 Doc#9	27	23.2	24.3	26.4 Doc#9	20 Msi (137.9 Gpa)	24.5 Doc 10	22.6	23.4	24.9	23	23.1 Doc#10	25.5 Doc#10
0.2% Yield Strength	72 ksi (496.4 Mpa)	114.3	126.3 Doc#9	128.2	112.4	102.1	109.5 Doc#9	34 ksi (234.4 Mpa)	56.9 Doc #10	57.4	65.2	54.9	54.8	63.9 Doc#10	56.5 Doc#10
Tensile Strength	95 ksi (655 Mpa)	157.5	187.7 Doc#9	182.1	176.4	166.6	166.9 Doc#9	78 ksi (537.8 Mpa)	93.9 Doc #10	93.7	95.2	92.1	88.2	98.1 Doc#10	85 Doc#10
Elongation	32%	16.0%	33% Doc#9	34.0%	48.0%	38.0%	34% Doc#9	36.0%	42% Doc #10	41.5%	38.0%	42.5%	37.5%	54% Doc#10	55% Doc#10
Charpy V – notch Energy	35 ft. lbs. (47.4 J)	36.33	51 Doc#11	54	53	48	48 Doc#11	50 ft-lbs (67.8 J)	100 Doc #10	98	103	117	93	111 Doc#12	102 Doc#12

Quick weld allowable calculation

- Sm = 2/3 Sy or 1/3 Sult at temp for all materials
- Sy = 93.2 ksi for Stelalloy butt weld since Sult is 157.5 -> Sm = 52.5 based on weld wire.
- Knockdown factor of 0.45 applied for visual inspected fillet welds. → **24 ksi**. Which is our max stress intensity we can incur statically.

Shim and pucks will be constructed of 316-L stainless steel.

Sy = 58 ksi at 77K *
Sult = 167 ksi at 77K *
► **Sm = 39 ksi (1/3 Sult)**

Item	Material	Allowable Sm (ksi)
shim	316L	48
weld	Lincoln Weld Wire	24
casting flanges	Stellalloy	54
compressive pucks	316L	48

*** Low-Temperature Fatigue of 316L and 316LN Austenitic Stainless Steels** J.-B. VOGT, J. FOCT, C. REGNARD, G. ROBERT, and J. DHERS 1991

Stress vs. Allowables

Item	Peak stress ksi	Allowable	F.S. on allowable
Puck	27.7	48	1.7
Shim	44.4	1.5 x 48=72	1.6
Weld	Max =36.6 (very localized- ignorable) Tip average ~24	1.5 x 24=36	1.5