Model data:
Units= Inches
Program used: AutoDesk Inventor Professional 2017
(https://www.autodesk.com/solutions/finite-element-analysis)

MESH DETAILS:
Number of Elements: 362,283
Average Element Size: 0.1”
Average Element Size in Shells: 0.05”
Element Type: Mix of solid and shell elements

- Bodies deemed too thin by program are converted to shell elements

Scantling log:

- Main Deck (1/4” A36 Plate with 5”x3”x1/4” stiffeners at 2’ spacing, see SS02.)
- Longitudinal Bulkhead 6’-8” off CL (5/16” A36 Plate with 5”x3”x1/4” angle stiffeners at 2’ spacing, see SS03.)
- Longitudinal Truss 13’-4” off CL (16”x4”x3/8” Flange Plate, at both main deck and bottom, see SS03.)
- Centerline Truss (16”x4”x3/8” Flange Plate, at both main deck and bottom, see SS03.
- Transverse Bulkhead @ Frame 6 (5/16” A36 Plate with 5”x3”x1/4” stiffeners at 20” spacing, see SS04.)
- Transverse Bulkhead @ Frame 12 (same as Frame 6.)
- Bottom (5/16” A36 Plate w 5”x3”x1/4” stiffeners at 2’ spacing.)

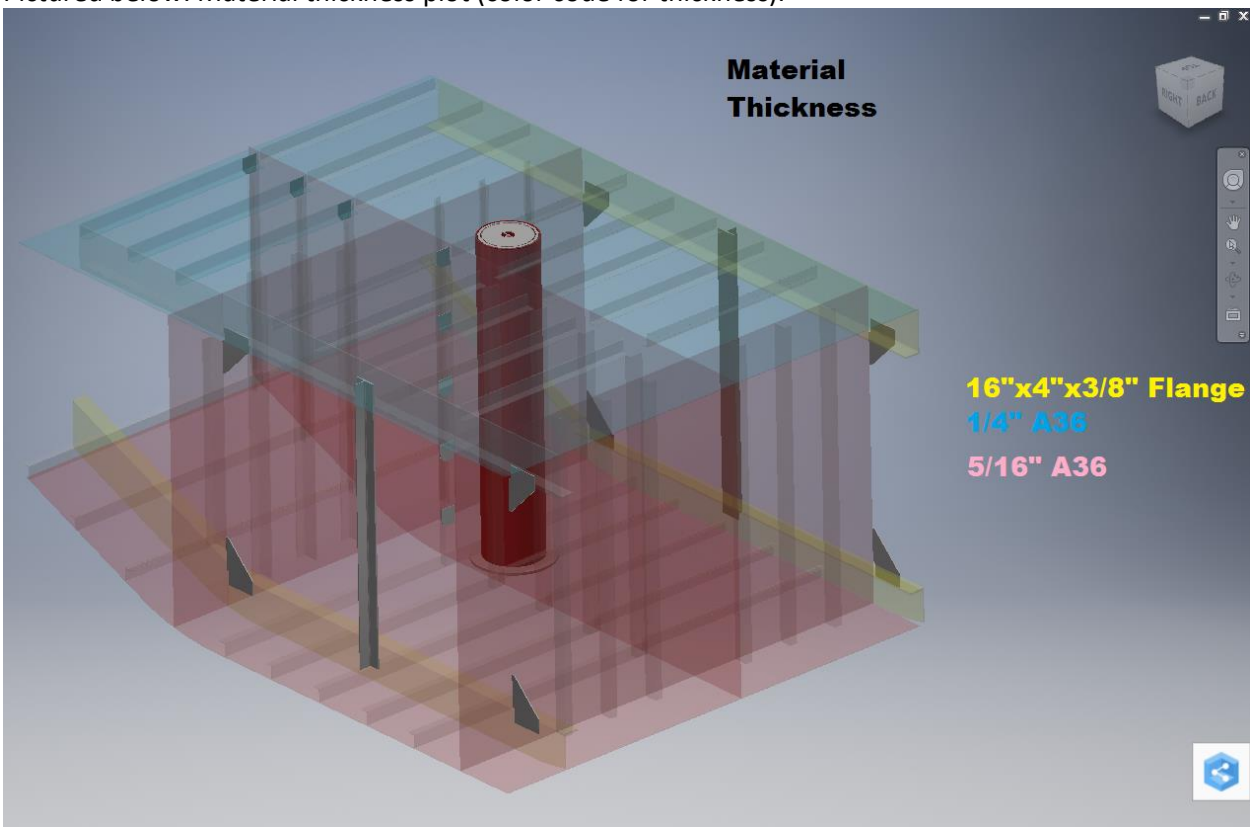
Also included in FE model:

- 22” O.D. Schedule 40 moonpool pipe (Grade X52)
- 48” x 48” x 3/8” main deck doubler plate, A36.
- 22” I.D. x 30” O.D. x 3/8 plate doubler at bottom, A36.
- Qty:2 ANSI W6x25 I-Beams (to which the ramset equipment sits atop.)

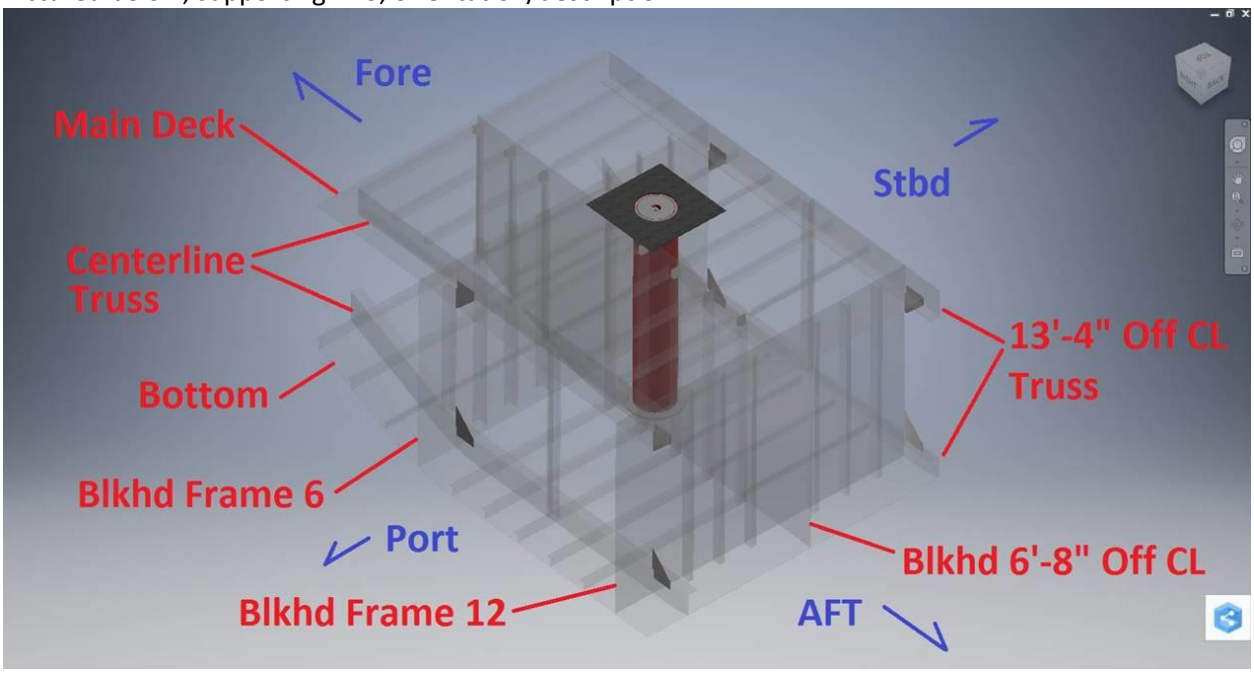
Not included in model:

- T-Handle Manhole Cover (as this will be removed during operations.)

Pictured below: Material thickness plot (color code for thickness).

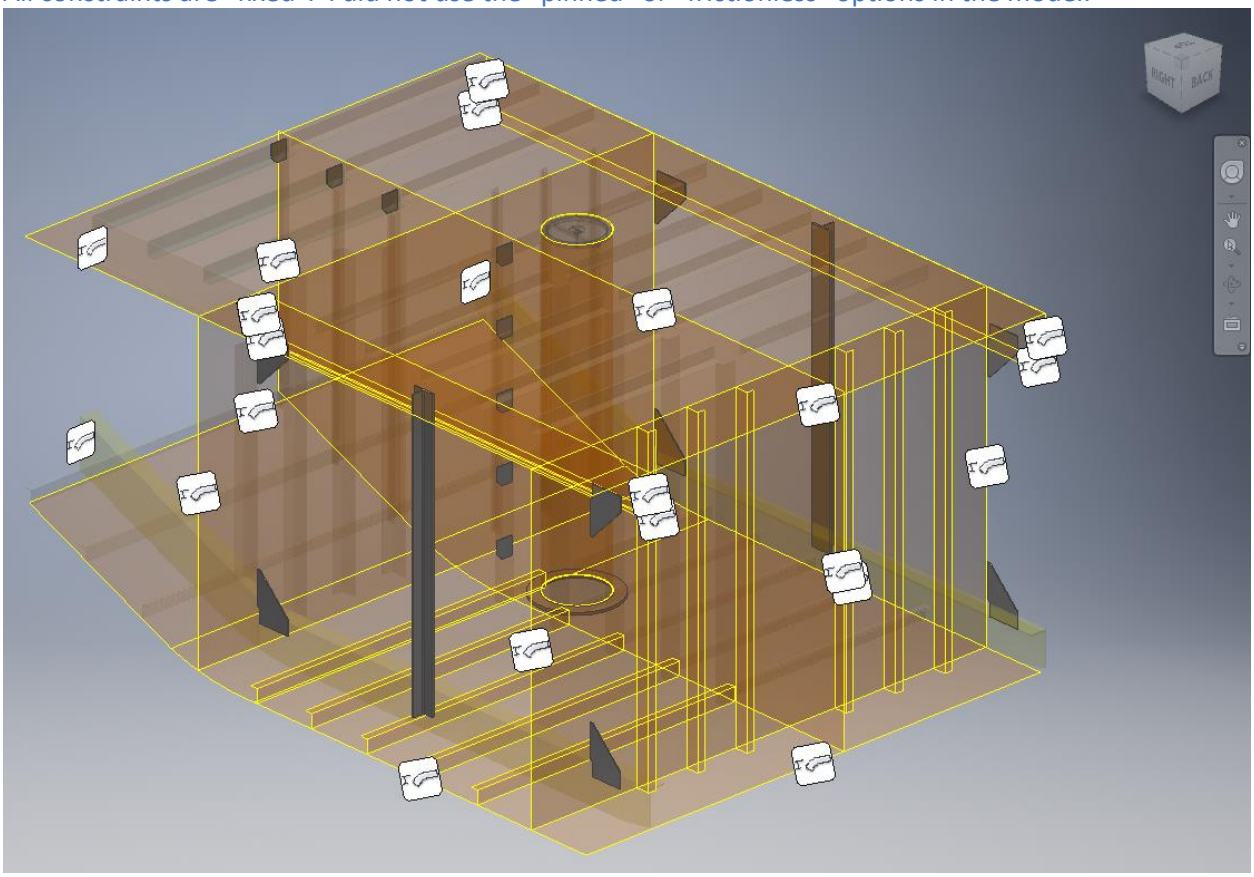


Pictured below, supporting info, orientation/description:



Boundary conditions (pictured below):

All constraints are “fixed”. I did not use the “pinned” or “frictionless” options in the model.

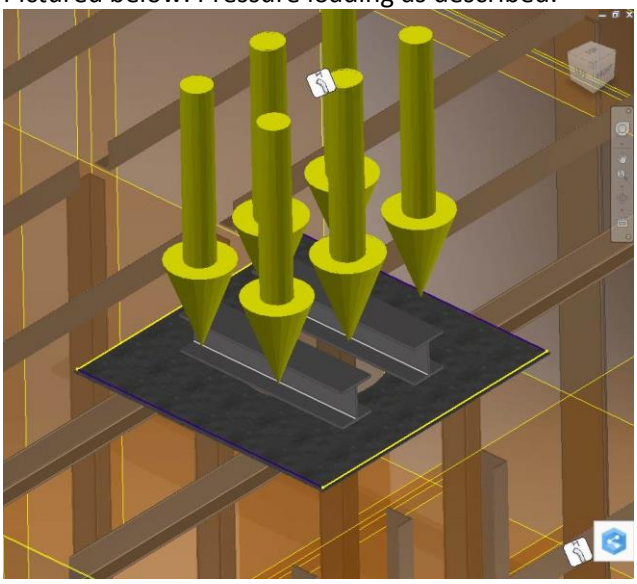


Loading statements:

- Ramset will sit atop a pair of ANSI W6x25 I-beams as pictured below, approx 30” in length.

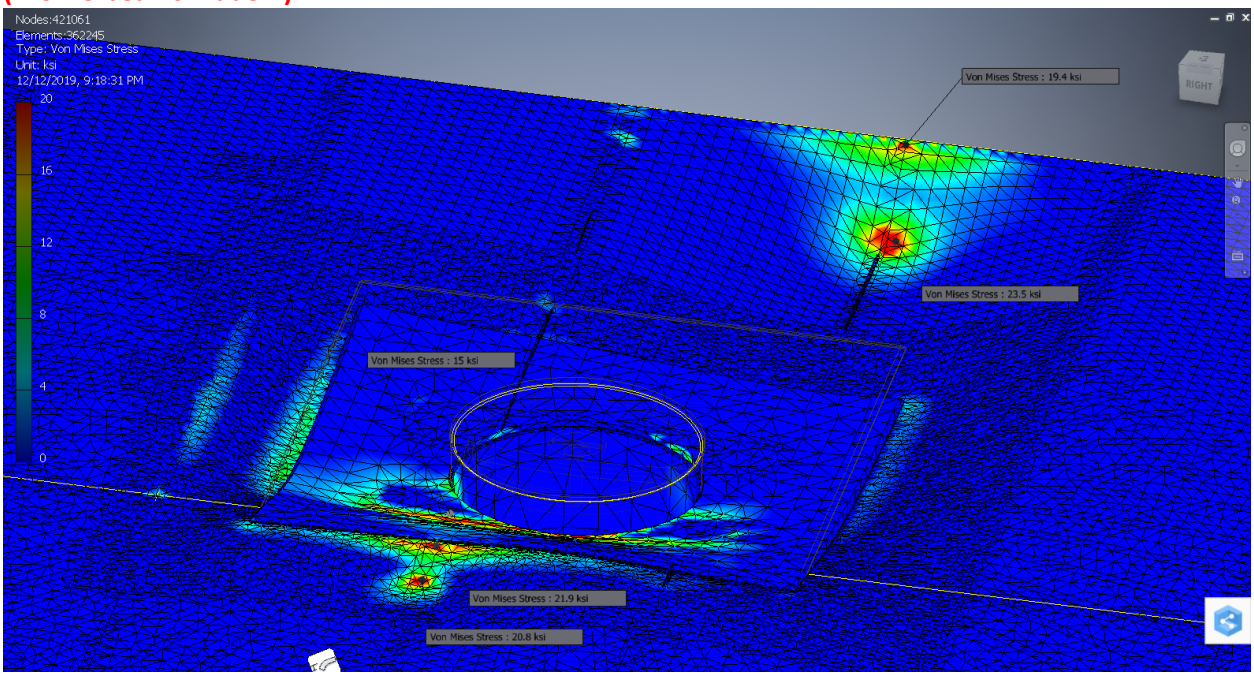
- The moonpool is under no loading in addition to ramset.
- The equipment and moonpool will only be used when elevated out of the water.
- No lateral loads have been taken into account. Actual loading will be a reaction force to work accomplished through the moonpool. Constrained by the 22” opening at the pool-bottom, we estimate loading will always be within 3 degrees of true-downward direction.
- The combined surface area of the top of the two beams is 380 in^2. A pressure load of 158 lb/in^2 is applied to these two beam tops (60,000 lb. divided by 380 in^2 = 158 lb/in^2).

Pictured below: Pressure loading as described:

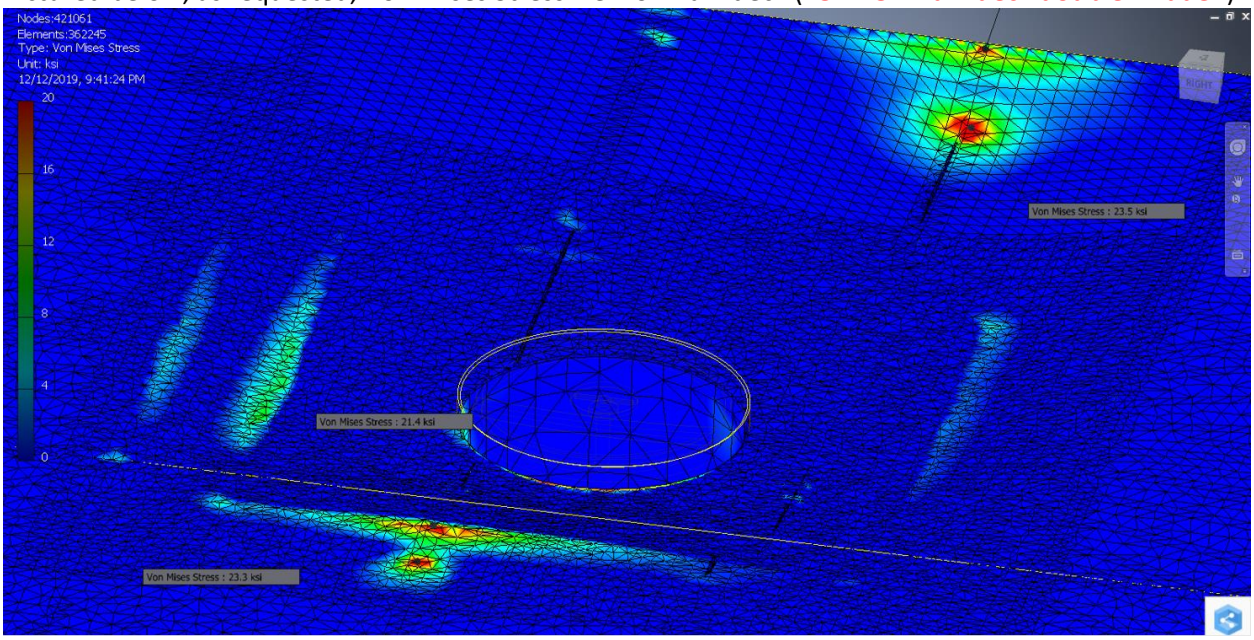


Results:

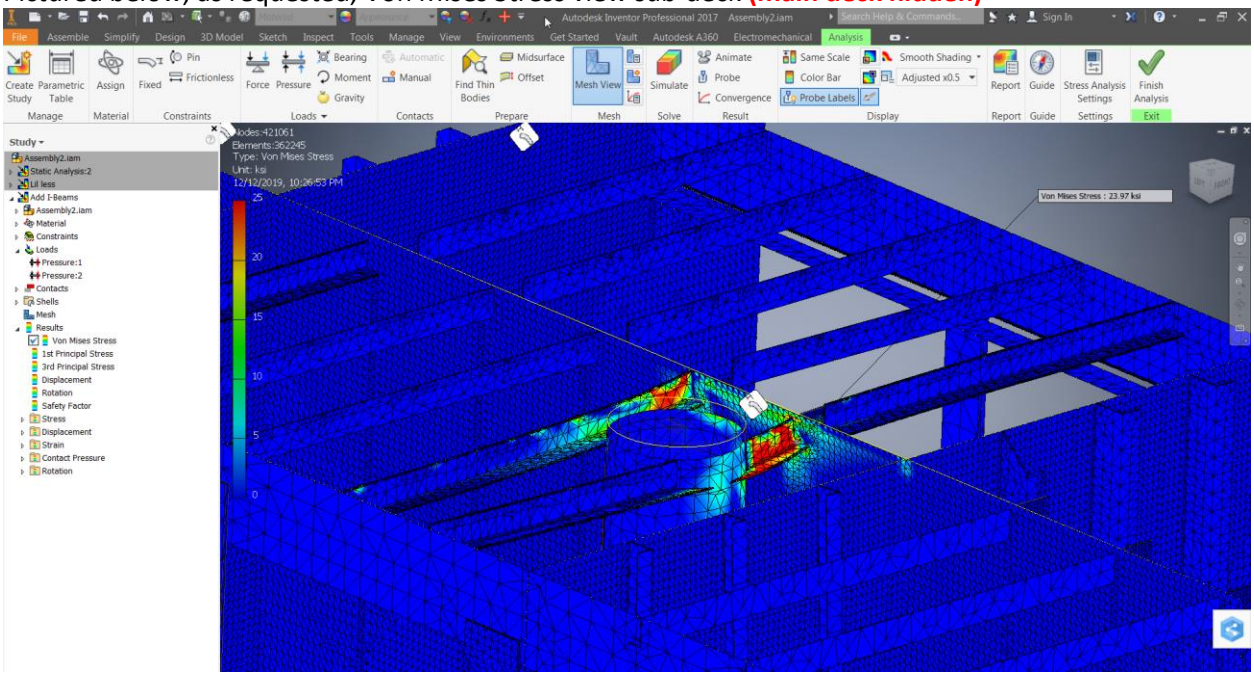
Pictured below, as requested, Von Mises Stress view of 48”x48” main deck doubler plate and main deck **(W6x25 beams hidden.)**



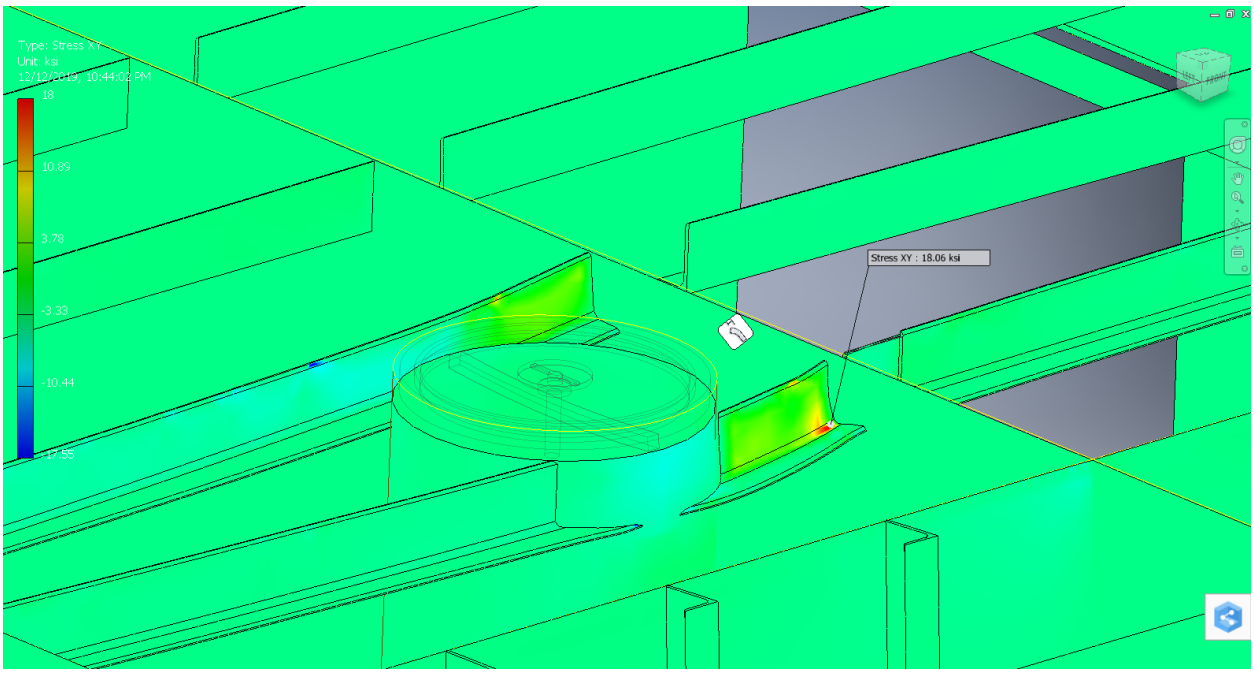
Pictured below, as requested, Von Mises Stress view of main deck (**48”x48” main deck doubler hidden**):



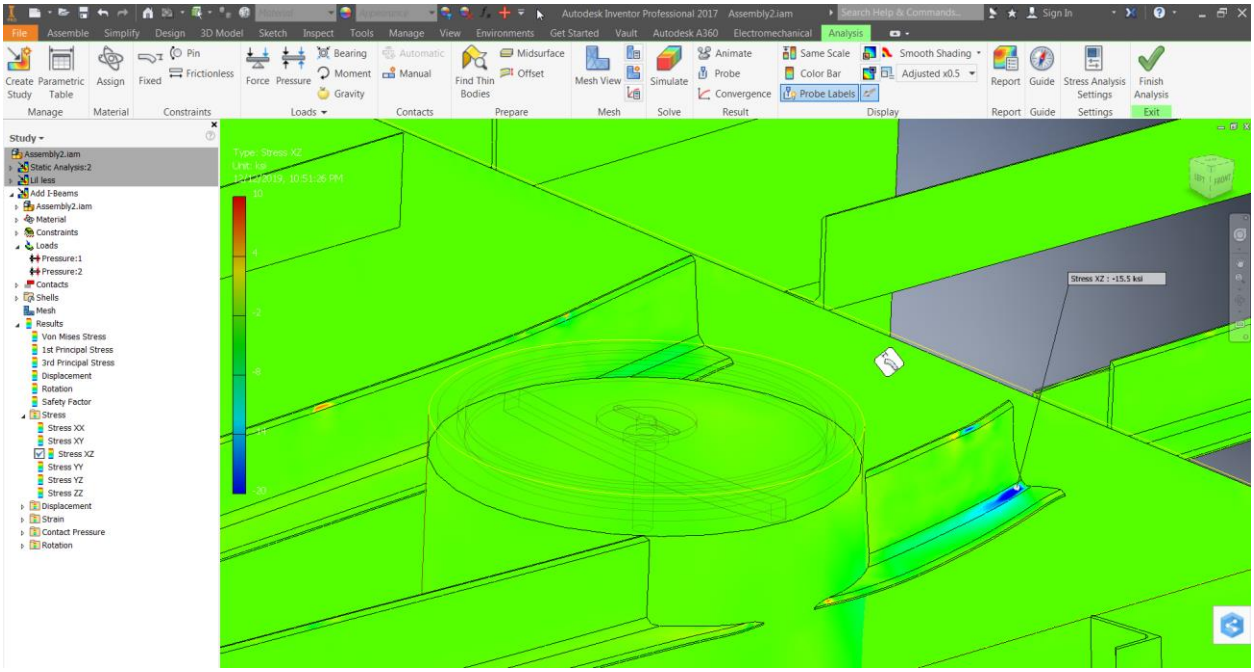
Pictured below, as requested, Von Mises Stress view sub-deck **(main deck hidden)**



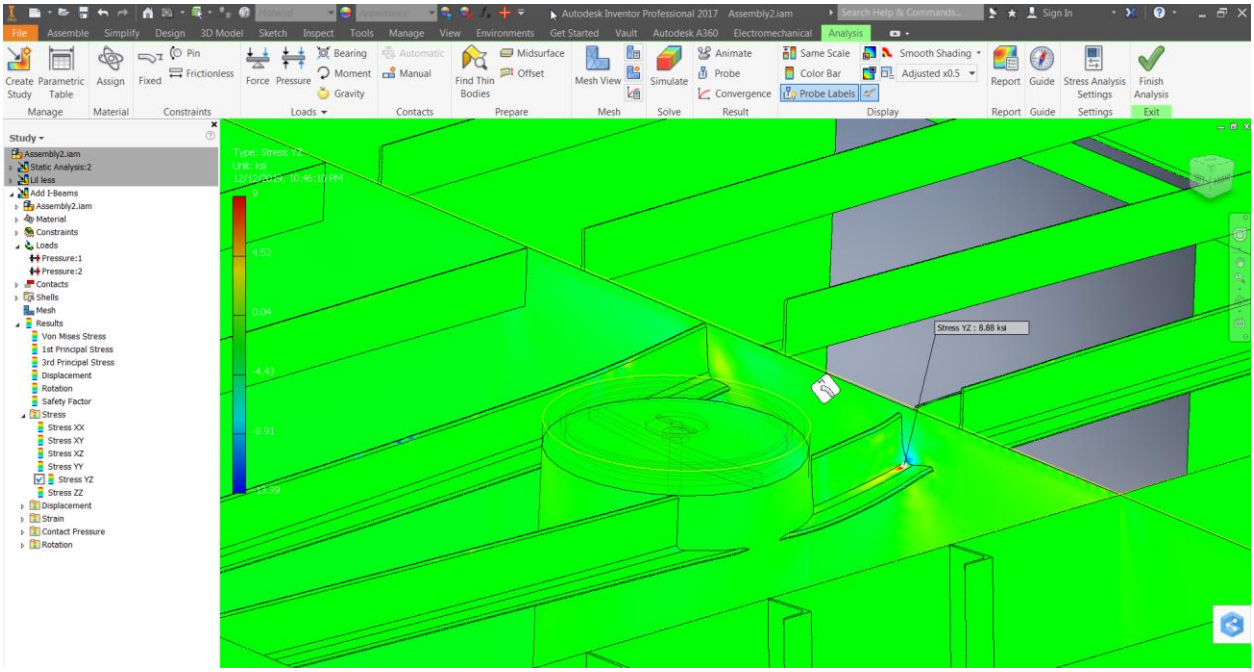
Sub-deck Stress XY:



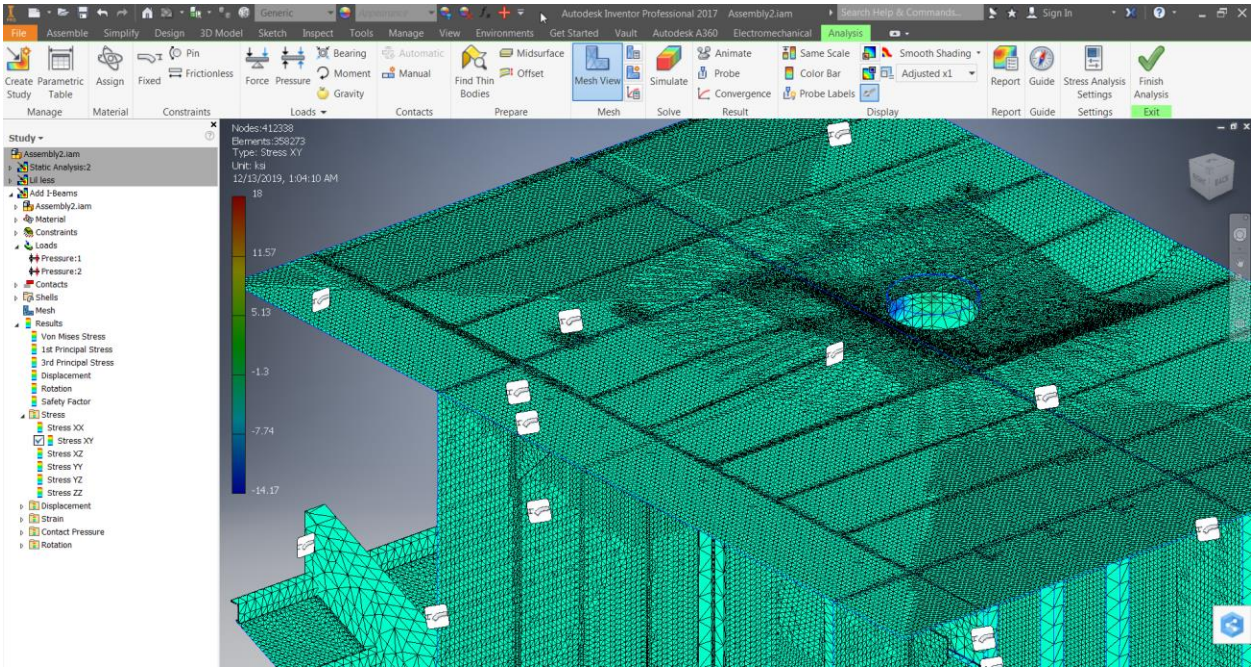
Sub-deck Stress XZ:



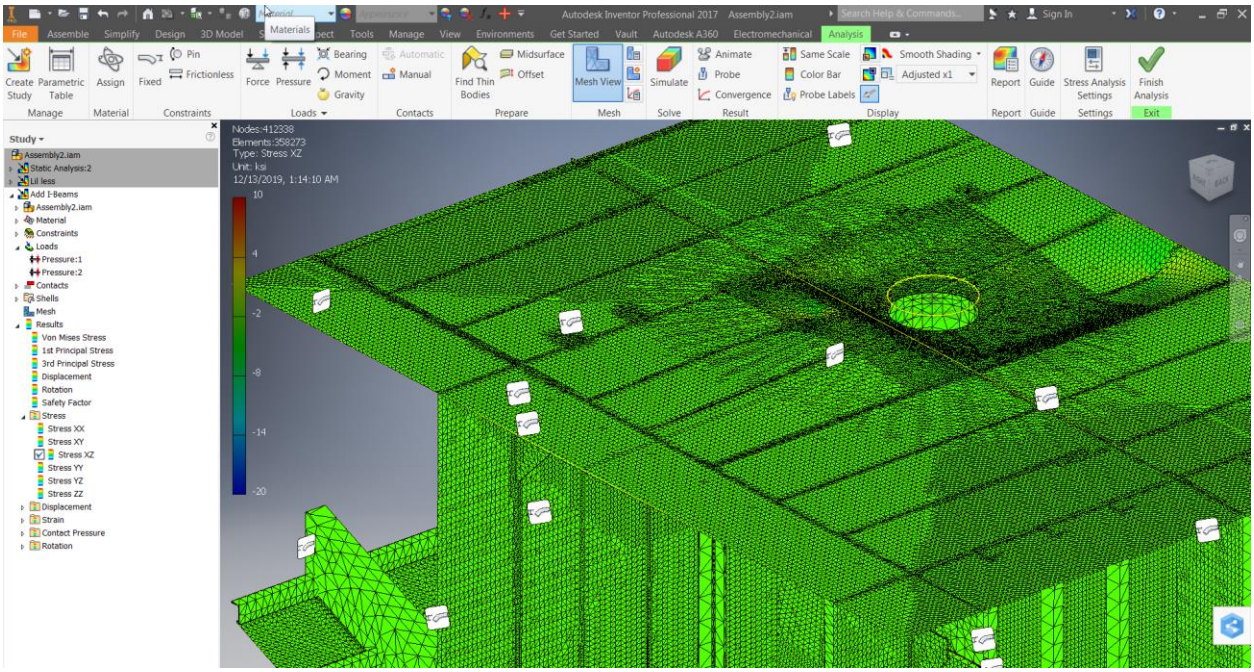
Sub-deck Stress YZ:



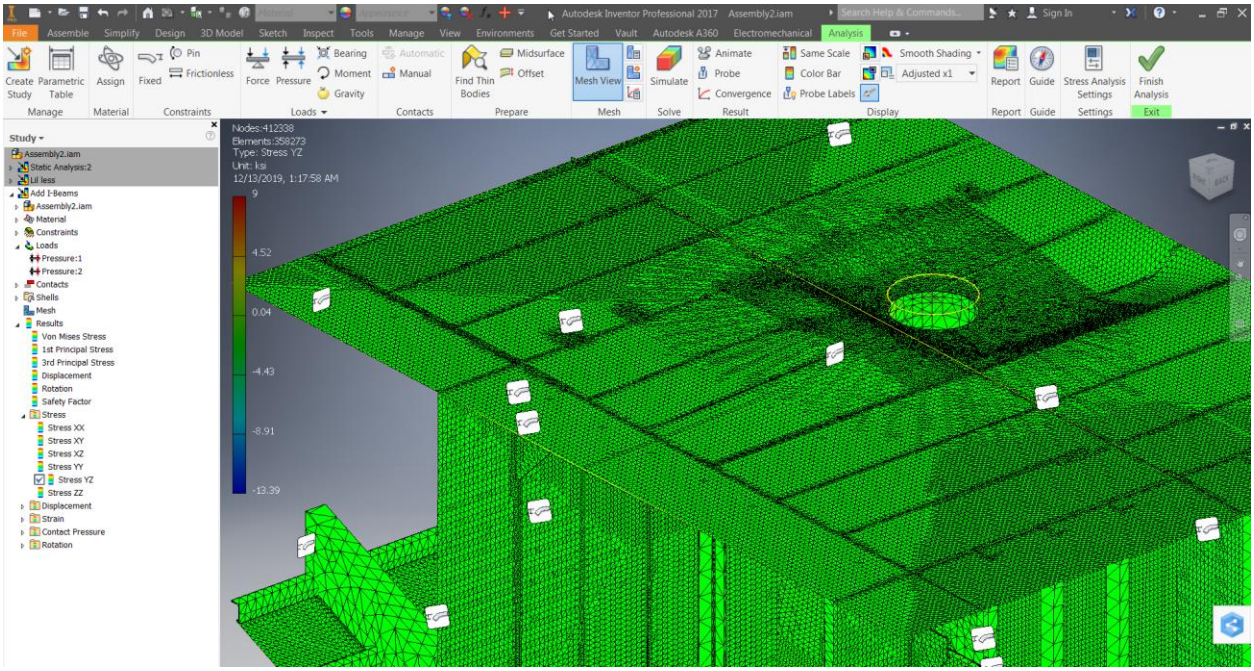
Main deck Stress XY:



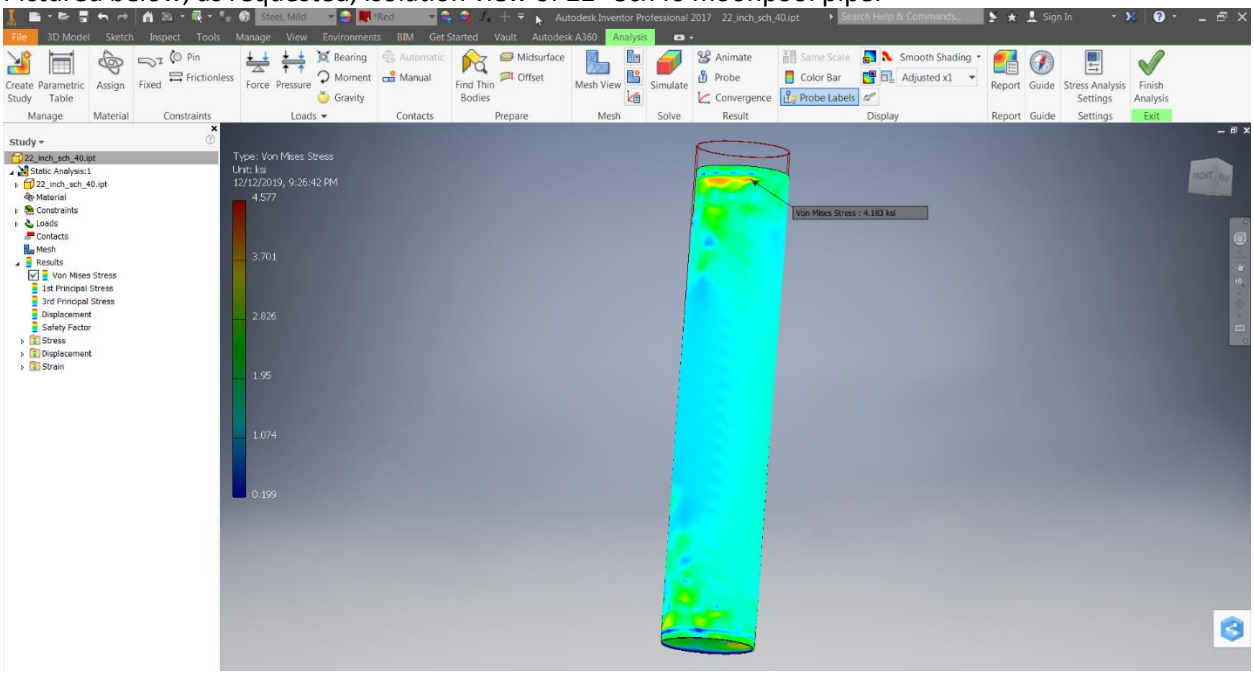
Main deck Stress XZ:



Main deck Stress YZ:

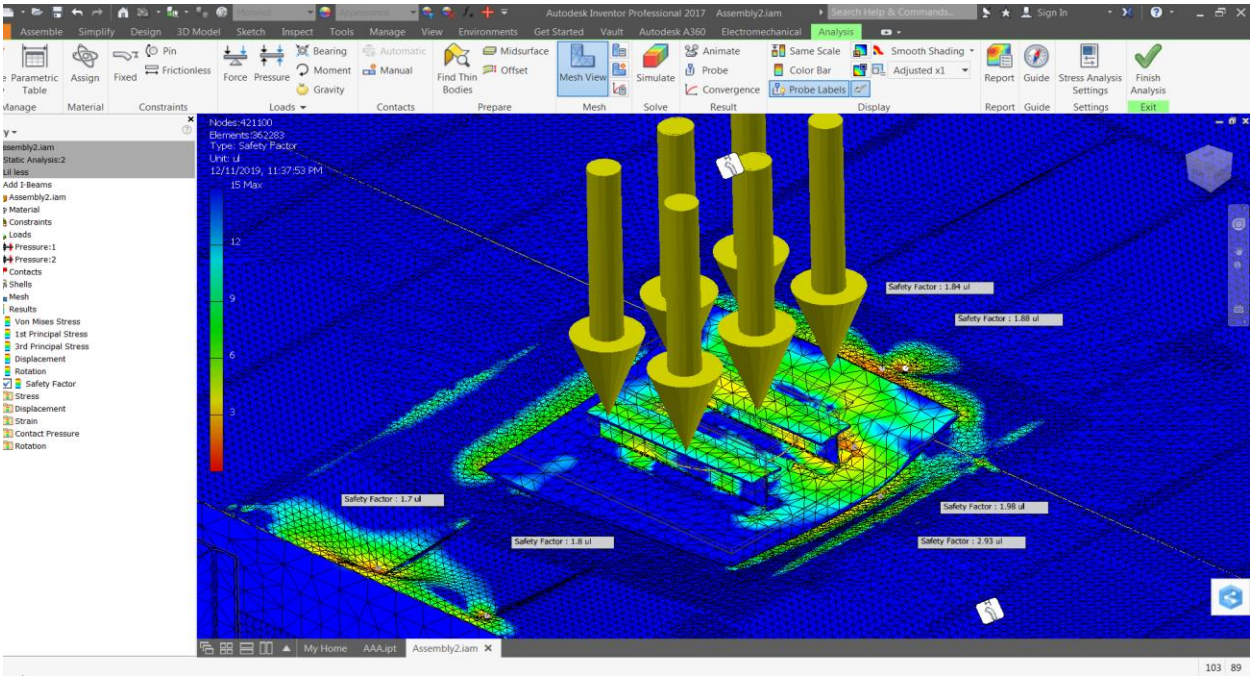


Pictured below, as requested, isolation view of 22” Sch40 moonpool pipe:



Stress acceptance criteria:

After discussion w LR, per LR ROU, we will use Load Case (a) – Combined "comparative" Stress with minimum Factor of Safety = 1.43



Lloyd's Register Rulefinder 2019 - Version 9.32

Lloyd's Register Rules and Regulations - Rules and Regulations for the Classification of Offshore Units, July 2019 - Part 4 Steel Unit Struc
Permissible stresses

Section 2 Permissible stresses

Parent topic: Chapter 5 Primary Hull Strength

2.1 General

2.1.1 For the combined load cases, as defined in Pt 4, Ch 3, 4.3 Load combinations, the maximum permissible stresses of factors of safety indicated in Table 5.2.1 Factors of safety for the combined load cases.

Table 5.2.1 Factors of safety for the combined load cases

Permissible stresses for:	Load case (a)	Load case (b)	Load case (c)	Load case (d)
Shear (based on the tensile yield stress)	2.5	1.89	1.89	1.72
Shear buckling (based on the shear buckling stress)	1.67	1.25	1.25	1.0
Tension and bending (based on the tensile yield stress)	1.67	1.25	1.25	1.0
Compression (based on the lesser of the least bucking stress or the yield stress)	1.67	1.25	1.25	1.0
Combined "comparative" stress (based on the tensile yield stress)	1.43	1.11	1.11	1.0

2.1.2 For plated structures, the combined 'comparative' stress is to be determined where necessary from the formula:

$$\sigma_{pc} = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x\sigma_y + 3\tau_{xy}^2}$$