D1900066-v5 HAM8 Door FEA Analysis

(Based off of previous analyses done by Chandra Romel)

November 5, 2019

Introduction

The new door designs for HAM7 and HAM8 can be found on the DCC as D1900059 and D1900066 respectively. The FEA described in this report was done on version 5 of the HAM8 door to verify structural integrity. The results in this FEA can be used as an accurate representation of the HAM7 Door as well because it is an exact mirror of this one. The analysis was conducted using ANSYS 2019.

Understanding the Analysis

The analysis done on this door was that of a shear failure model. In order to confirm the door's compliance to the failure model and thus ensure its structural integrity while installed and under vacuum load, a shear stress model was demonstrated and the max shear stress across the dish head (away from the nozzles) was taken for consideration. This max shear across the dish head of the door is not to be confused with the max shear across the entire door (which normally occurs near discontinuities). In fact, in order to distinguish the two from each other, the max shear stress near the nozzles was also called out for comparison.

Analysis Properties and Settings

Four different analysis attempts were done on this door with differing element sizes in order to ensure that the model converged. The worse case model was chosen for the figures in this report.

The 2 cases observed are as follows:

Case 1: Pressure of 14.7psi applied to surfaces shown in red (Figure 1) and fixed supports applied to all 40 bolt holes in door flange

Case 2: Same pressure and fixed supports applied with the addition of 500lbs point force applied in the –Y direction on 12" Conflat of new A+ FB beamtube port.

The 3 resulting solutions found included the total deformation of the door, the Von Mises stress, and the shear stress.

Material is stainless steel with a tensile yield strength of 30ksi.

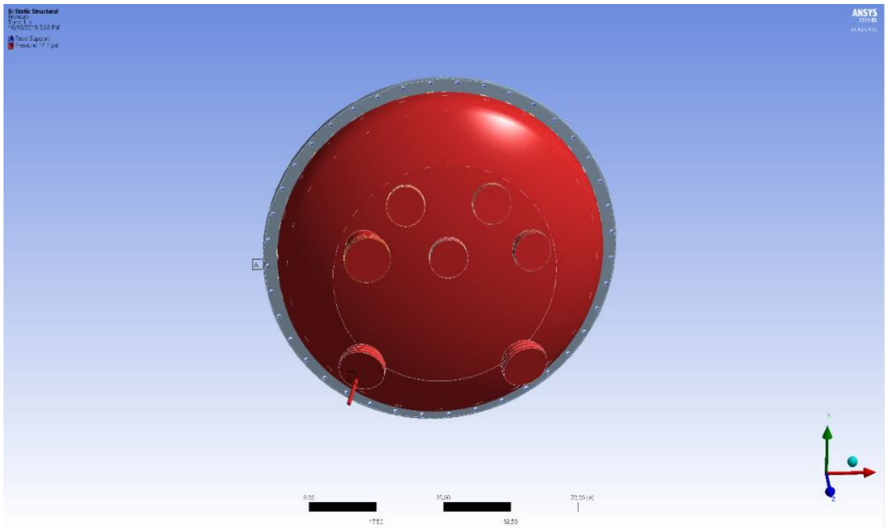

Figure 1: Pressure (14.7psi) and Fixed Supports (40 bolts) Applied

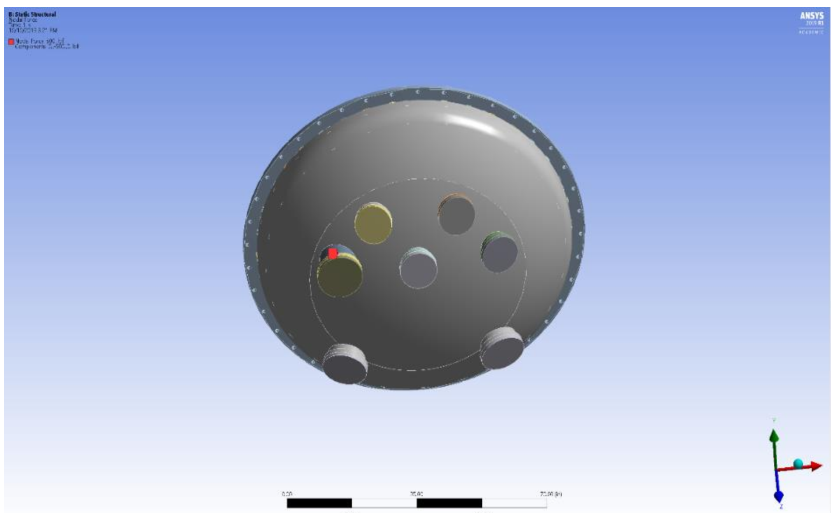

Figure 2: 500lbs Point Force Applied to A+ Cavity Filter Port

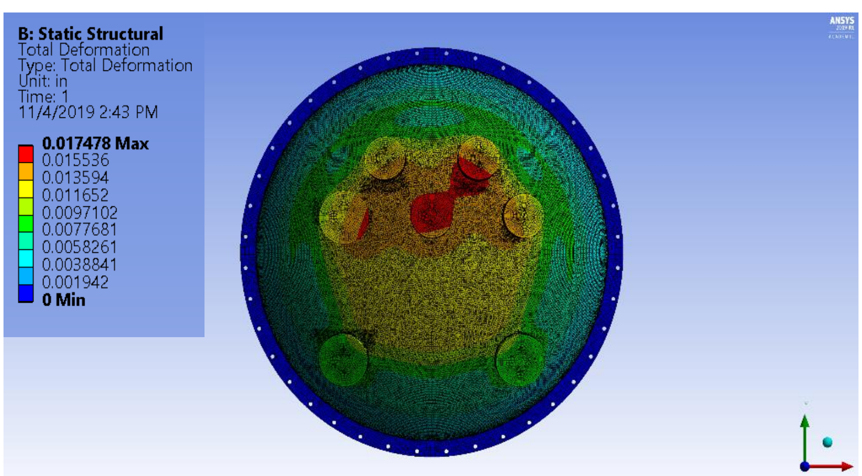

Figure 3: Max Deformation: 0.018" (approximate for both cases)

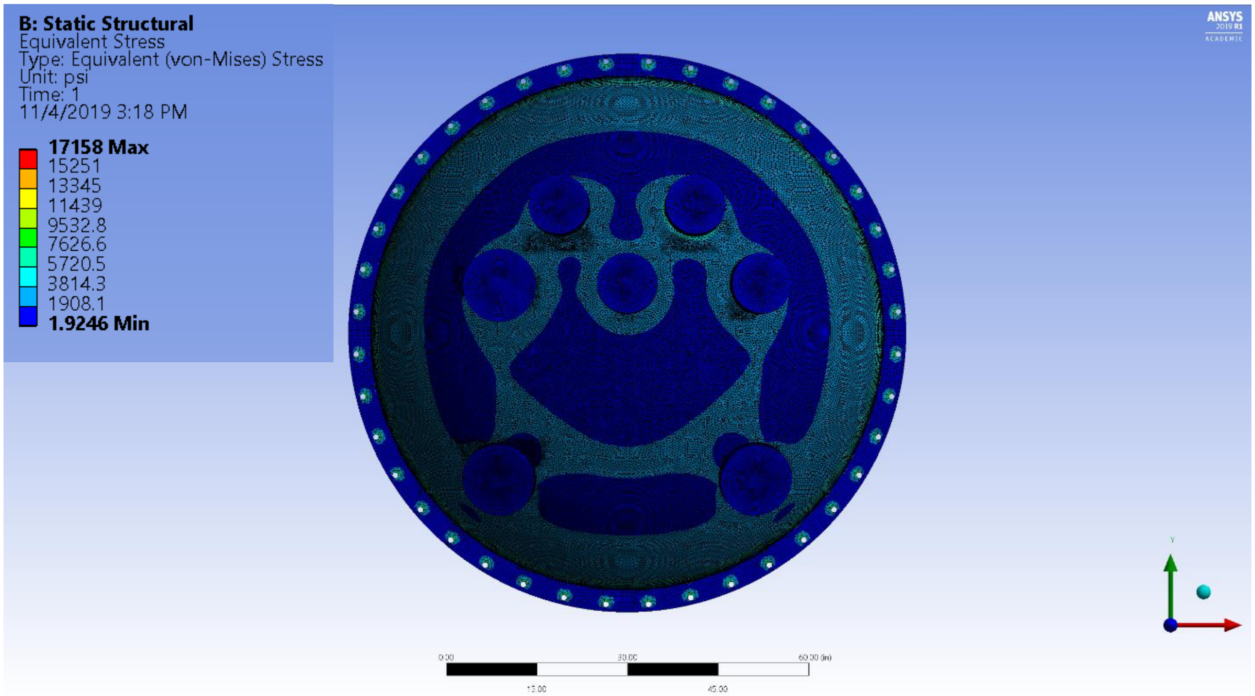

Figure 4: Case 1 Von Mises

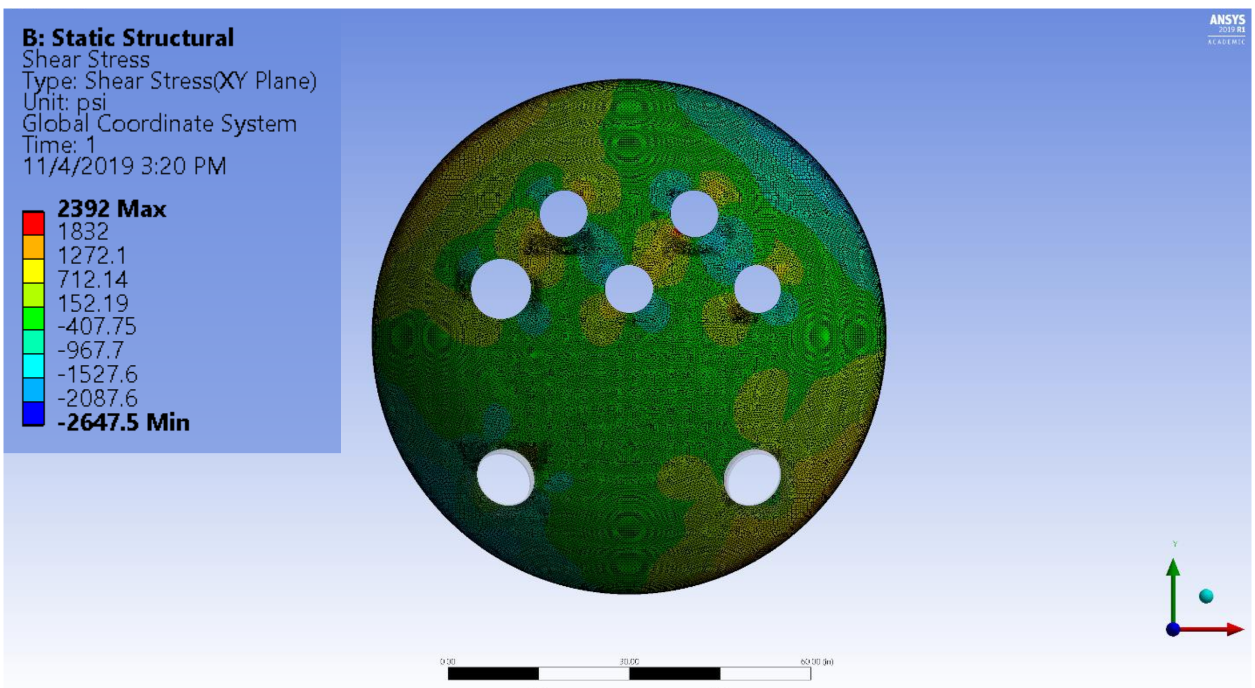

Figure 5: Case 1 Shear Stress
Max Over Dish Head = ~712psi
Max Near Nozzles = ~2392psi

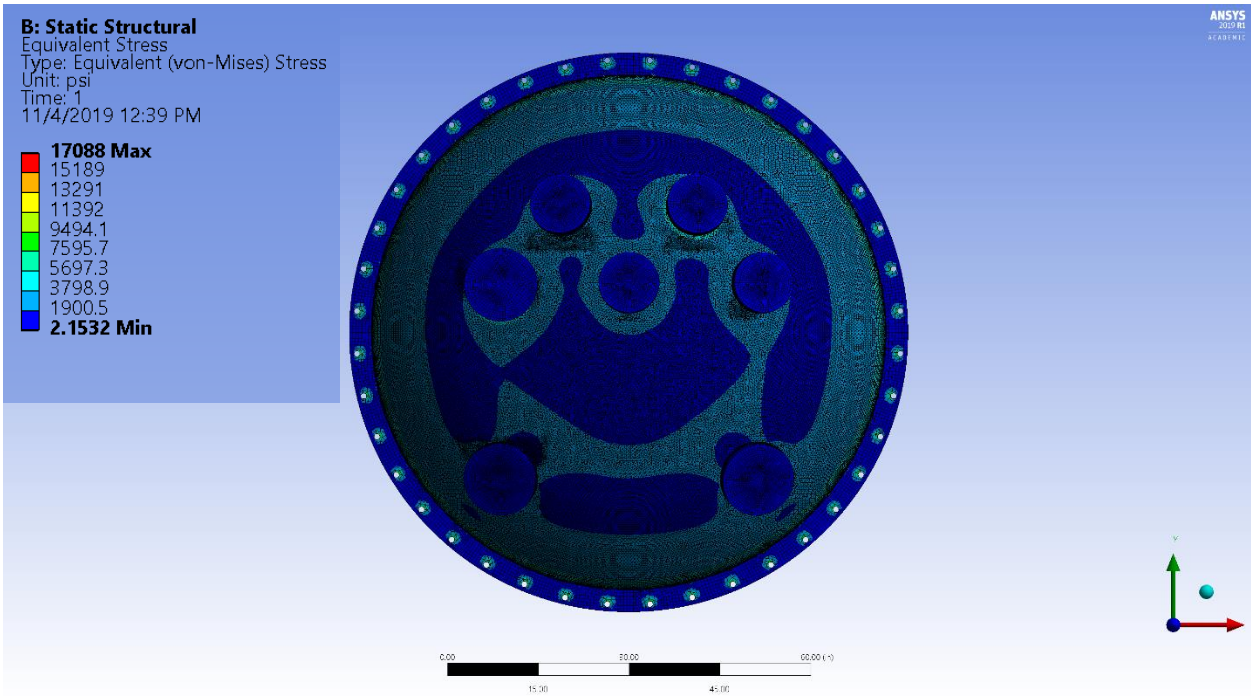

Figure 6: Case 2 Von Mises

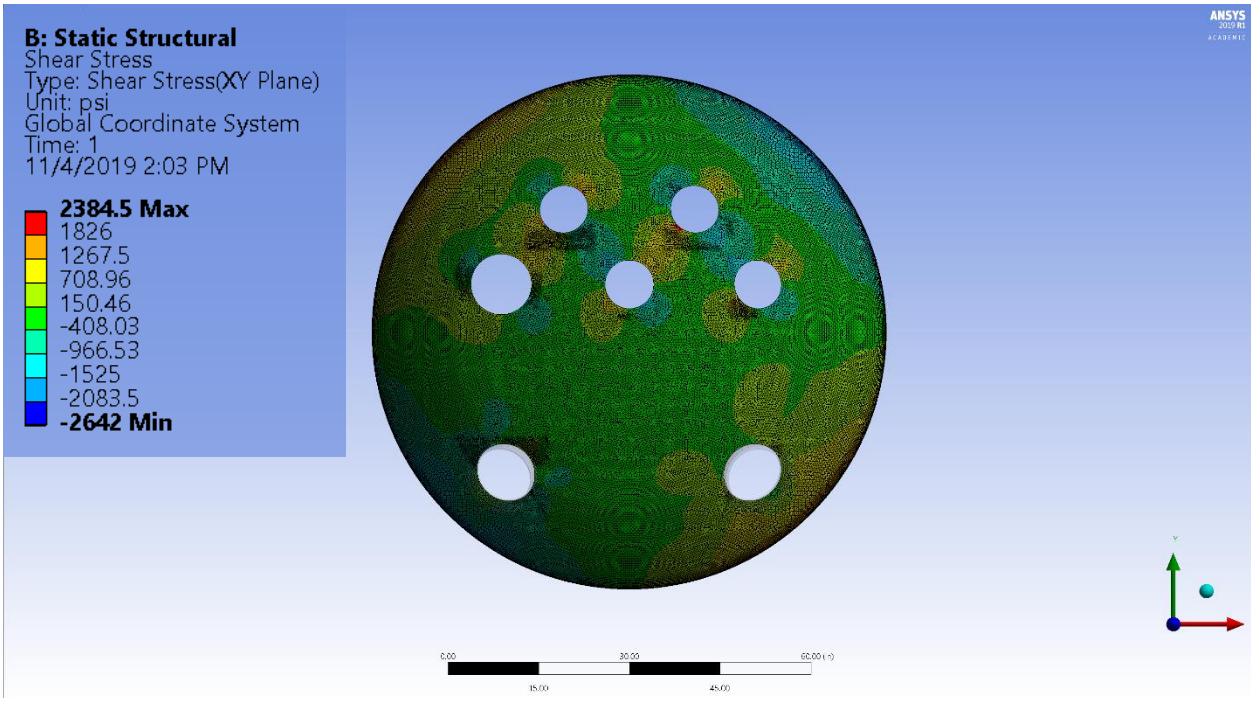

Figure 4: Case 2 Shear Stress
Max Across Dish Head = ~708psi
Max Near Nozzles = ~2384psi

Summary

Explanation of Data Gathering:

When taking values from this model to come to a conclusion on whether or not the model complied with the ASME standards, discontinuities such as the nozzles and flanges were considered overall but evaluated separately from the dish head as more of a worst case scenario.

Important Equations and Values:

- Stress Intensity (per ASME BPVC) = 2 x Max Shear Stress
- Max Allowable Design Stress Intensity (remote from discontinuities) = 20,000 psi
- Max Allowable Design Stress Intensity (near nozzles) = 1.5 x 20,000 = 30,000 psi
- Stress Intensity Ratio (Safety Factor) = (Allowable Design Stress Intensity) / (Measured Stress Intensity)
  - A ratio greater than 1 means that your results comply with the ASME BPVC
  - A ratio less than 1 means that your results don't comply to the standard

Analysis Results:

Case 1							
Element Size (in)	Element Count	Max Shear - Dish Head (psi)	Stress Intensity 1 (Max = 20ksi)	Safety Factor 1	Max Shear - Near Nozzles (psi)	Stress Intensity 2 (Max = 30ksi)	Safety Factor 2
Default	92137	766.73	1533.46	13.04	2359.9	4719.8	6.36
0.5	475865	630.24	1260.48	15.87	2138.1	4276.2	7.02
0.48	472203	827.14	1654.28	12.09	2313.6	4627.2	6.48
0.52	462582	712.14	1424.28	14.04	2392	4784	6.27
Case 2							
Element Size (in)	Element Count	Max Shear - Dish Head (psi)	Stress Intensity 1 (Max = 20ksi)	Safety Factor 1	Max Shear - Near Nozzles (psi)	Stress Intensity 2 (Max = 30ksi)	Safety Factor 2
Default	92137	771.4	1542.8	12.96	2364.8	4729.6	6.34
0.5	475865	504.6	1009.2	19.82	2135.9	4271.8	7.02
0.48	472203	836.92	1673.84	11.95	2318.9	4637.8	6.47
0.52	462582	708.96	1417.92	14.11	2384.5	4769	6.29

See C1000445 for reference on the failure model used for this analysis and how that analysis was derived.

The Von Mises portion of this analysis (reference E1800236) is not needed for signoffs of this documentation, so it will be completed at a later date.