Rainbow Camera Mount – Stress Analysis

Revision A

Organization: Laboratory for Aerosols, Clouds, and Optics (LACO)
Location: Physics Department at the University of Maryland, Baltimore County (UMBC)
PI: Doctor Vanderlei Martins
Engineer: John Hall

Date: March 14, 2012

Instrument Layout:

The following diagram shows the aircraft mounting plate with the instrument located (and no other instruments shown). Further details can be found in the presentation or computer model supplied with this report.

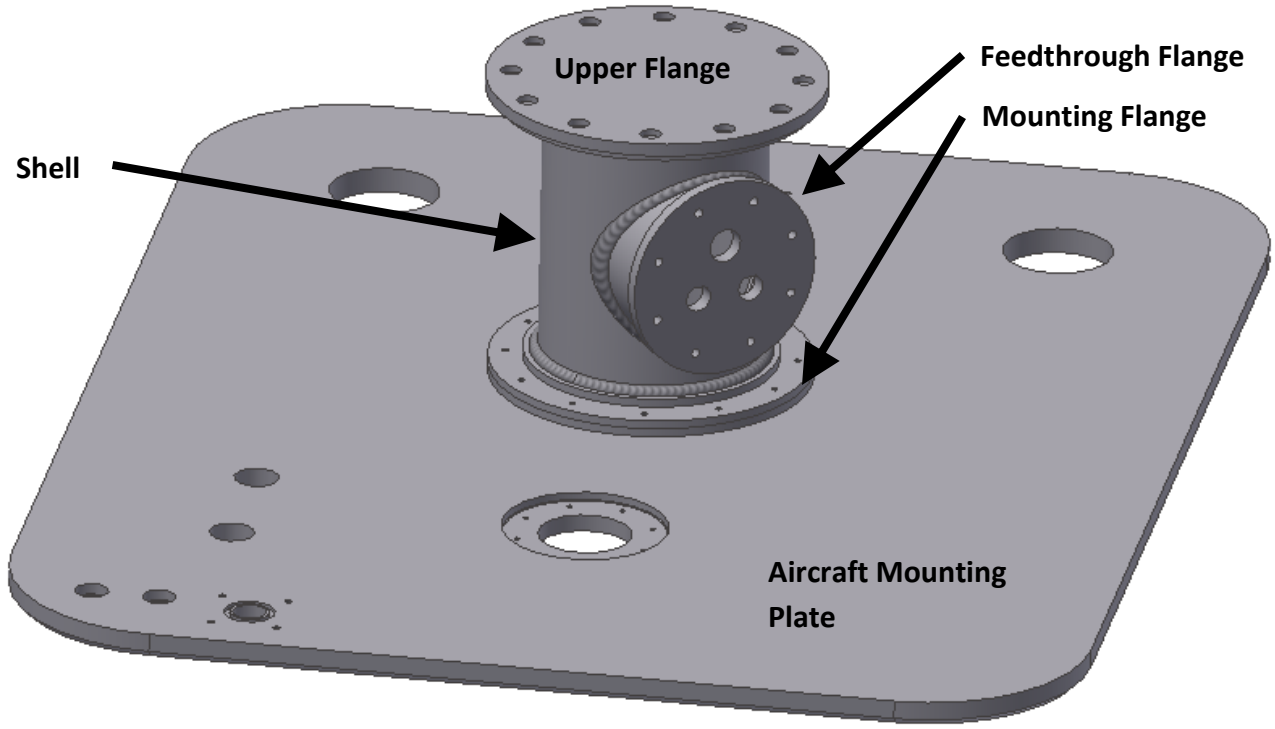

Figure 1 - Instrument Components

Design Conditions:

1. Contacts:
    a. The tested surfaces include the upper flange, shell, feedthrough flange, and mounting flange. These components compose the minimum components needed to create a pressure barrier. The components when assembled mount via the mounting flange to the aircraft plate.
    b. Twelve (12) 1/4-20 bolts holds the upper flange to the shell.
    c. Eight (8) 1/4-20 bolts hold the feedthrough flange to the shell.
    d. Twelve (12) 1/4-20 bolts holds the mounting flange to the shell.
    e. Eight (8) 10-32 bolts hold the mounting flange(and the instrument overall) to the aircraft plate.
2. Constraints
    a. The aircraft plate is considered fixed.
    b. The bolts are applied by their size, location, and bound components.

c. Instrument material is Aluminum 6061-T6 unless noted, and screws are stainless steel. The shell is considered to be Aluminum 6061-O (annealed) due to welding; these properties may be lower than actual, but should provide a conservative estimation.
d. Revised part constraints used to form the shell. The simulation software now handles these joints as welds verse plain connection. A test with and without the welded contact type shows very little increase in stresses, but the update was applied.

3. Loads:
   a. Pressure is applied on the aircraft internal surfaces of the instrument. The magnitude applied is thirty pounds per square inch (30 psi). *NOTICE: The outside of the aircraft will be lower pressure than the inside; for this reason, the pressure is applied as if the inside pressure is at the loaded pressure.*
   b. The bolts have 1.25x the force needed to withstand the forces due to pressurization. *Example: The ten (10) inch upper flange will have an applied force of 2,356 pounds at thirty pounds per square inch (30 psi). With twelve (12) bolts, each bolt will see 196 pounds. Therefore, the analysis applied 1.25x or 245 pounds per bolt.*

Results:

The largest stresses are seen near bolted connections and in the shell wall. The maximum stress of 3373 psi is found at a bolt which may be due to FEA stress concentrations. Stresses in the shell wall are approaching 1200 psi near the welds and 800 psi in the open face. At this stress, the margin of safety until yielding is calculated to be 1.47 at the bolts, about 8 in the shell wall, and around 7 at the shell welds.

Figure 2 shows the finite element analysis (FEA) results for stress distribution. Figure 3 shows the FEA results for the safety factor distribution when yielding is considered failure. Note that the FEA package used utilizes safety factor instead of margin of safety; margin of safety is safety factor minus one.

From these calculations, the stress distribution shows that the instrument is designed for the estimated flight conditions. The margin of safety is considerable for major areas including the shell face and welds. Near the bolts, the margin of safety is lower, but still safe.

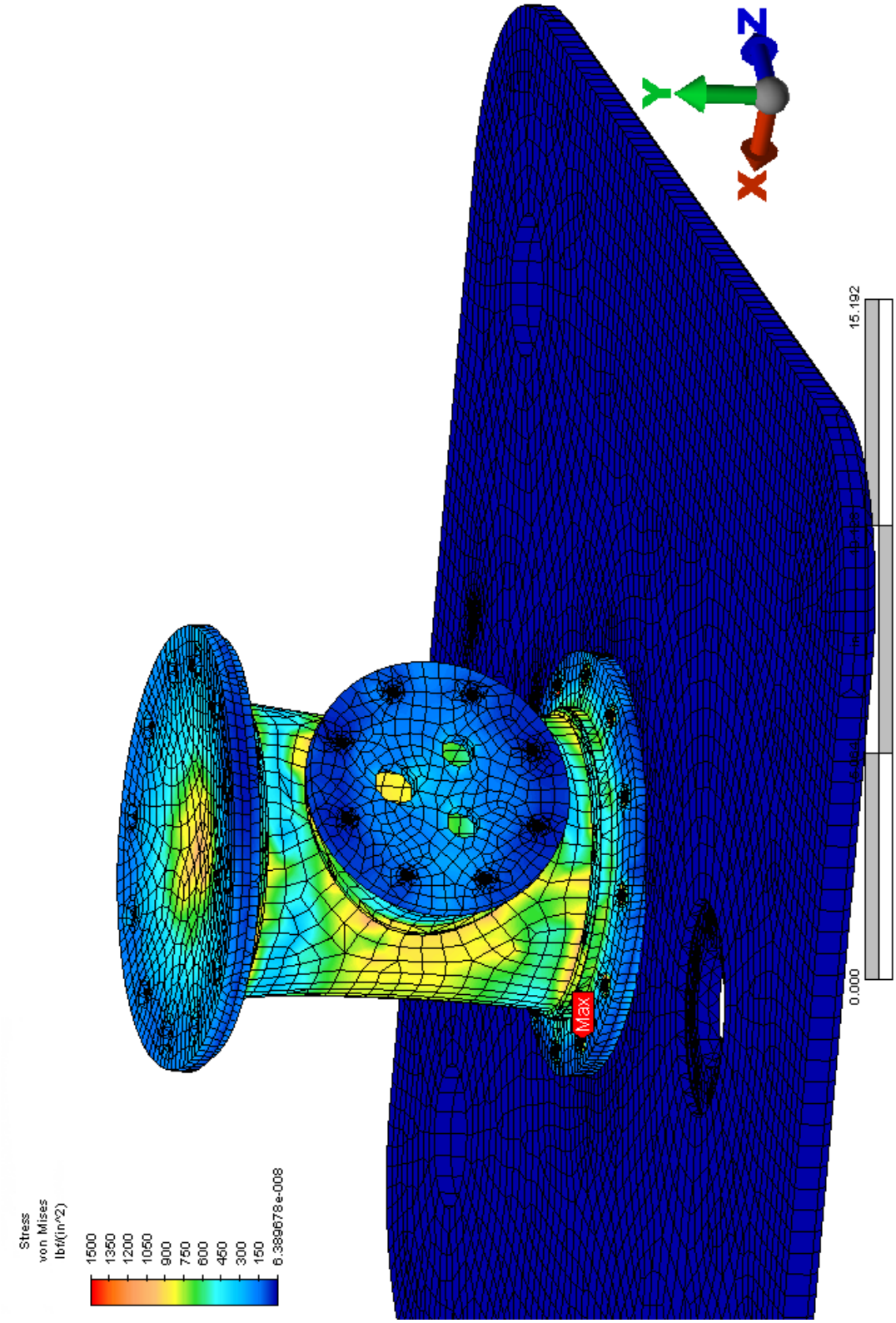

Figure 2 - FEA Stress Distribution

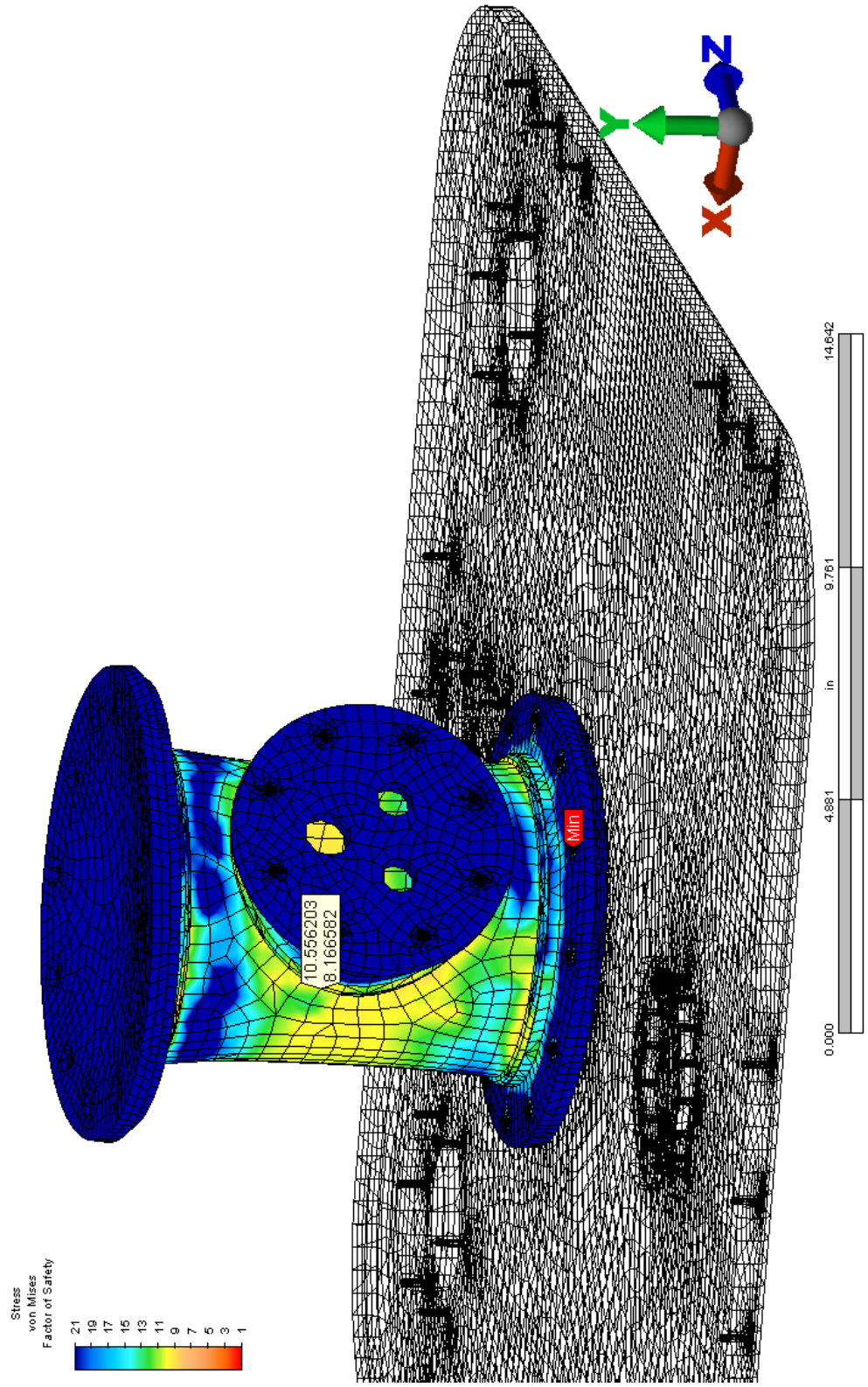

Figure 3 - FEA Safety Factor Distribution *(Note: Factor of Safety is represented)*

Revision History

Revision A – March 14, 2012		
1	Design Conditions	Changed: material specifications.
2	Design Conditions	Added: welded contact verse plain contact for welded shell.
3	Results	Changed: use of margin of safety over safety factor
4	Results	Updated: values for major stresses and margins of safety.
5	Results	Updated: Findings/Conclusion
6	Results	Updated: Figure 2 and Figure 3