

Orbital ATK Launch Vehicle Enclosure

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Abstract

Orbital ATK's space-bound vehicles are launched from coastal regions around the United States. Prior to launch these vehicles are inspected and processed on the launch pad. The launch vehicles are exposed to variable weather conditions during this period. Orbital ATK has interest in developing an enclosure for launch vehicles to protect against such hazards, while being quick to assemble and disassemble. Multiple unique concepts were developed based on a 60 ft. tall launch vehicle. The selected design focuses on the use of lightweight industry materials specific to Orbital ATK. This provides a solution that is cost effective and can be scaled to launch vehicles of different sizes. Maintenance costs were limited with the use of readily obtainable construction materials. Computational analyses and physical experiments were conducted to test the final design concept. A 1/6th scaled launch vehicle enclosure was constructed to provide Orbital ATK with a demonstrative prototype of the system. The design presented is a valid solution to the need of protection for launch vehicles and may also have additional applications for Orbital ATK outside of the intended use.

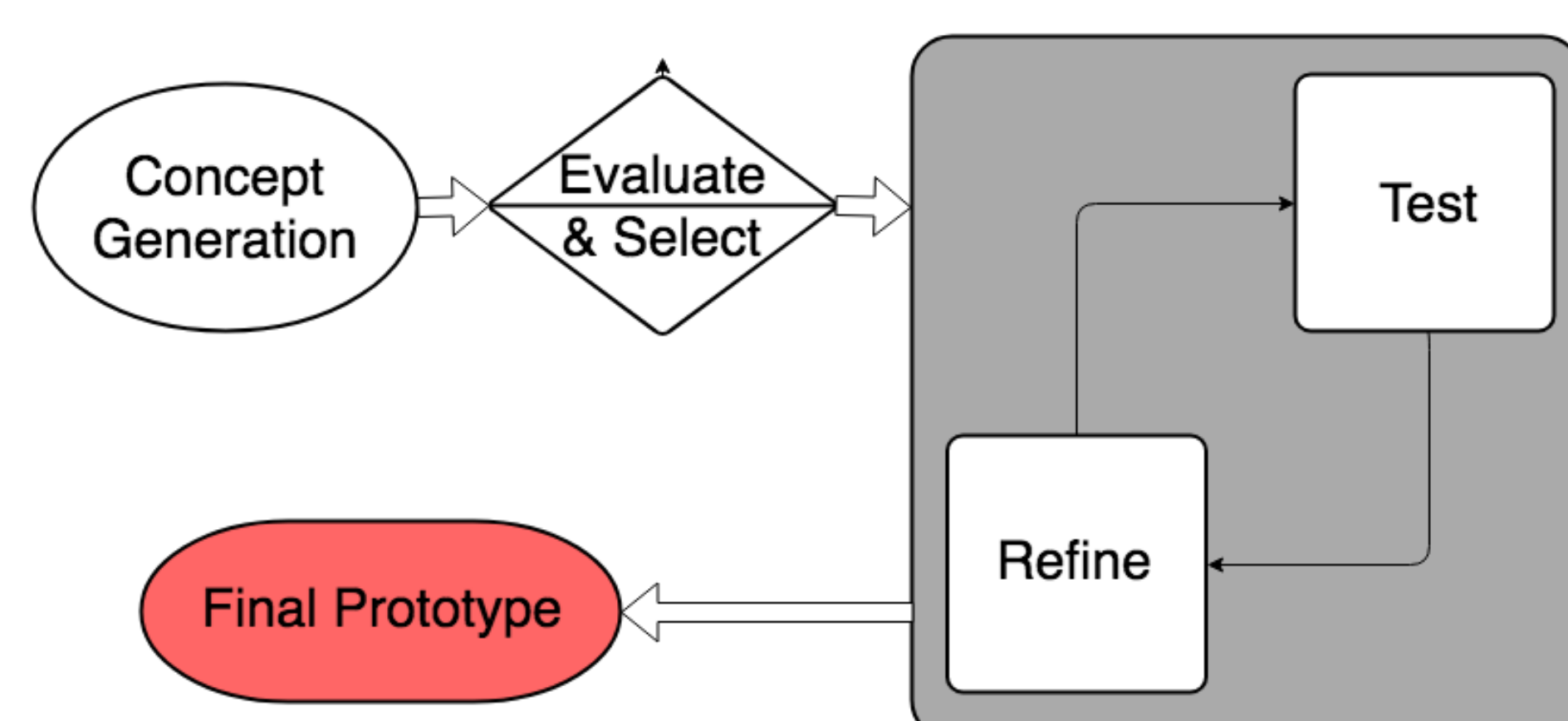
Project Goals

Project goals were identified through Orbital ATK's requirements for a launch vehicle enclosure.

Customer Need	Target Value
Solar Protection	354 W/m ²
Moisture Protection	603 g/m ² /24hr
Launch Vehicle Contact	1 m
Accessibility	25m ²
Time of Assembly	60 min
Time of Disassembly	30 min
Factor of Safety (FOS)	3 for yield & 5 for ultimate

Design Process

The design process was subdivided into four main steps in order to deliver an acceptable end product.



Final Design

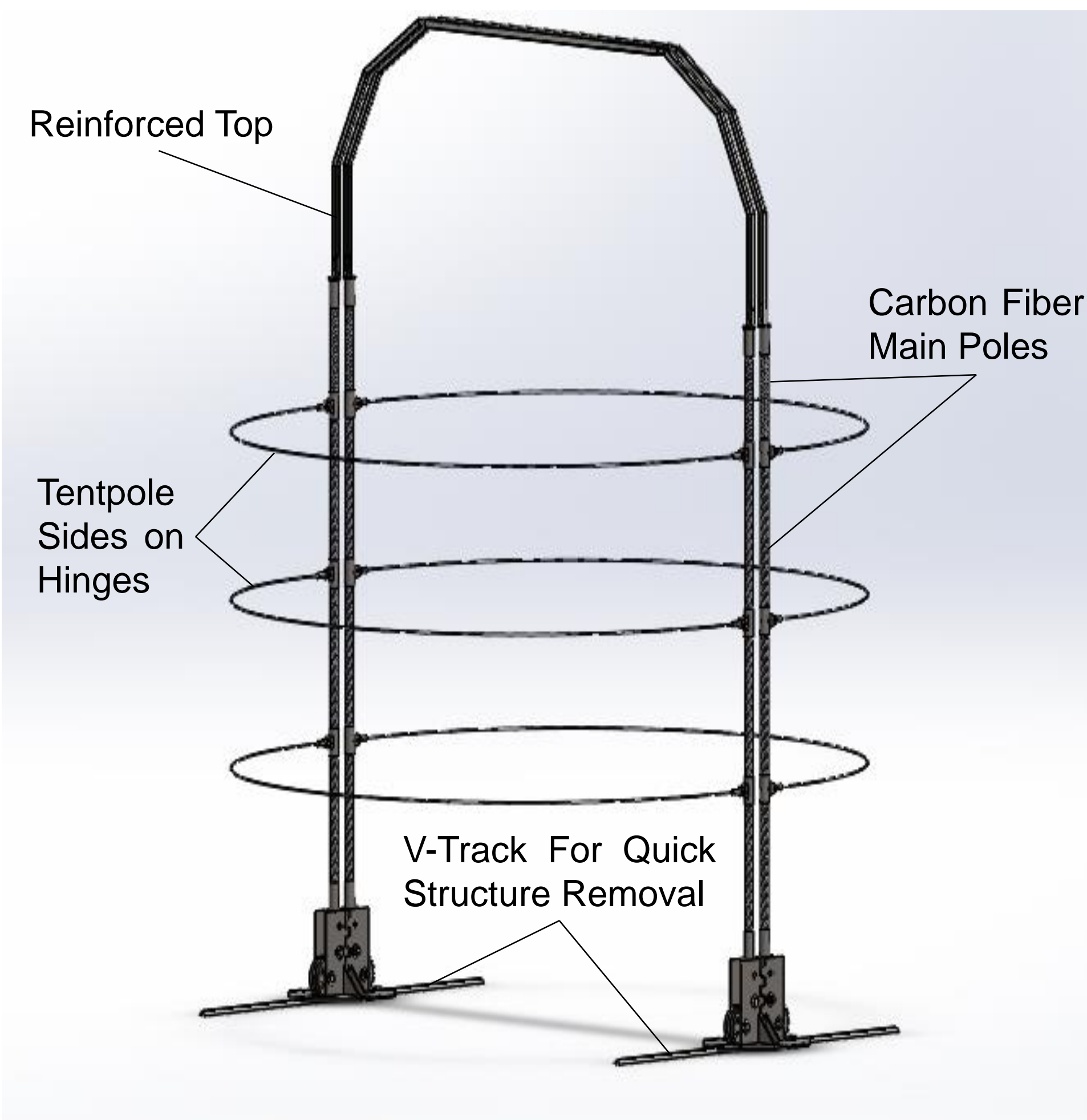


Figure 1. Labeled CAD model of the launch vehicle enclosure without the water-resistant fabric skin while in deployed state.



Figure 2. Base of the enclosure while in undeployed state.



Figure 3. Actual deployed 1/6 scale enclosure with partial water-resistant fabric skin deployed.



Figure 4. Actual 1/6 scale enclosure in the undeployed position.

Analytical Analyses

A total of 8 analytical analyses were performed to confirm the validity and feasibility of the design while meeting all customer needs. Analyses performed included:

- Deflection
- Degradation
- Flexural Strength
- Heat Transfer
- Permeability
- Stresses (FOS)
- Wind Loads (Two Approaches Taken)

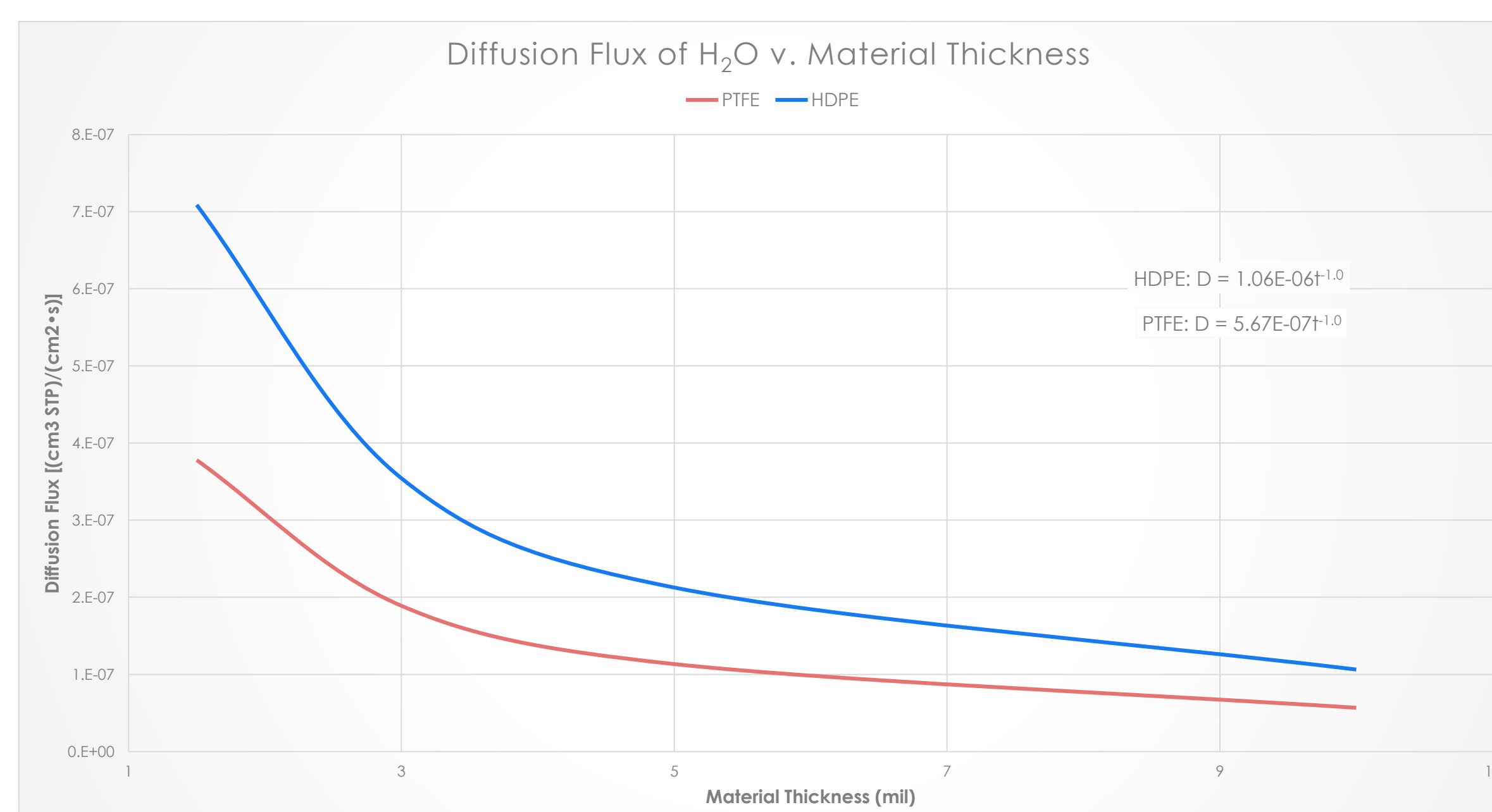


Figure 5. Permeability analysis result for PTFE and HDPE

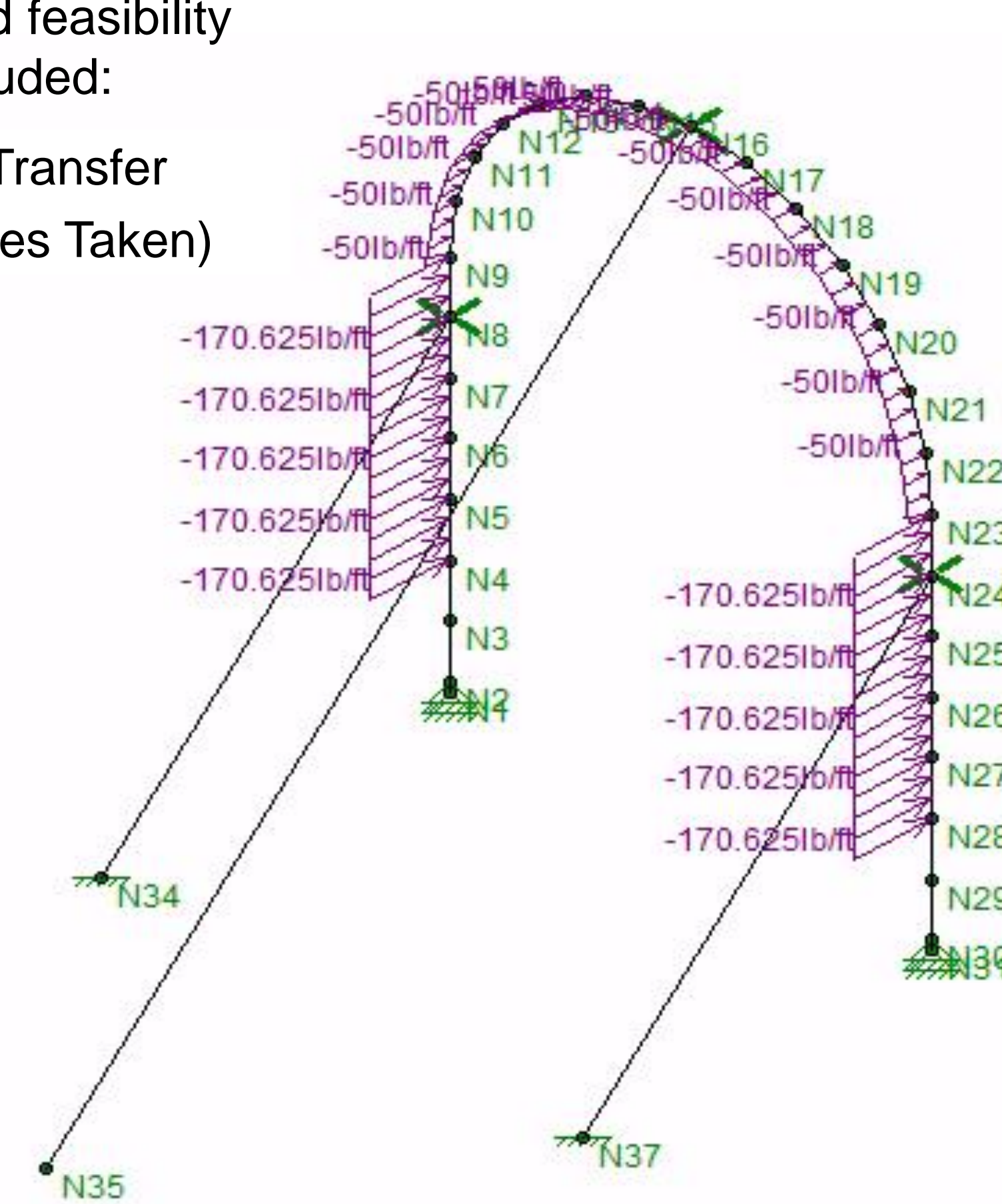


Figure 6. Stress analysis model created in RISA 3D

Testing

Testing Procedure	Engineering Requirement Tested
Assembly	-Assembly Time -Number of Assembly Steps -Disassembly Time
Accessibility	-Footprint and entrance dimensions
Temperature Effects	-Workspace Temperature -Rocket Temperature -Heat Flux
Three Point Bend	-Strength -Stress -Factor of Safety
Flow Visualization	-Airflow through structure -Ventilation
Cost Analysis	-Cost per unit height for scalability
Operation Testing	-Functionality of all components
Material Endurance	-Usage Quantities -Life Span

Results

All construction and final testing was completed on the launch vehicle enclosure prior to the final delivery date of May 3, 2018 to Orbital ATK. This design may be adopted by Orbital ATK for use at one of the primary launch sites across the United States.



Figure 7. Orbital ATK launch sites in the contiguous United States [1]

References

[1] Orbital ATK, "Minotaur Space Launch Vehicles," *Space Launch Vehicles*, p. 2. [Online]. Available: www.orbitalatk.com

Acknowledgments

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