Launch structure and umbilical ground disconnect system: design, development, and testing.

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AEROSPACE SERVICES

Launch team at Benbecula in the Outer Hebrides

Magdalena Kraus
Email: magdakraus97@gmail.com
LinkedIn: www.linkedin.com/in/kraus-magdalena

Abstract

Hybrid launch vehicles require a part of the propellant to be stored in liquid phase. Therefore, an umbilical disconnection ground system is required to allow the transport of liquid propellant into the launch vehicle. Such system is part of the loading line and must withstand disconnection forces while meeting design objectives.

Project Background

All space vehicles require a ground umbilical system for servicing. These requirements often include propellant loading and venting, pneumatic system supply, electrical power and control. Umbilical subsystems usually include an allignment system, mating and locking system, fluid & electrical connectors and a control system.

Company Background

Gravilitab Aerospace Services specialises in reusable sub-orbital launch vehicles for the purpouse of providing microgravity testing and space access. The products include hybrid rockets and a UAV microgravity testing platform.

Project

The umbilical disconnect system and launch structure have been designed based on the hybrid launch vehicle requirements, therefore it included subsystems responsible for actuation, control, alignment system, fluid connector, and a locking system. The design has been done using SolidWorks. Moreover, a computational structural analysis has been performed in order to verify if the structure can withstand the dynamic forces of the quick disconnect hose fitting of about 80N. The design was actuated using two linear actuators with the stroke of 200mm and 300mm controlled by a series of switches, sensors and a relay. Moreover, parts were specifically manufactured for the mechanism which led to a reduction of total weight and optimization of the structure, the manufacturing processes included waterjet cutting, 3D printing, turning, cutting, and drilling.
The full structure has been successfully built in the given time frame, it has been tested prior to and during launch and has proven successful. The system was correctly pressurized & disconnected and the launch structure has met the 6m height, 80kg of maximum weight, 0-15° launch angle, and stability requirements for the hybrid propellant launch vehicle.

Launch vehicle positioned on the launch structure and connected to the umbilical ground system ready to be pressurised prior to launch.

Conclusion

The design and tests of the umbilical disconnect structure as well as the 6-meter launch structure itself, have proven successful throughout the de-risking launch activity at Benbecula in the Outer Hebrides. For future operations involving larger vehicles, the umbilical disconnect system can be reused as it has proven to withstand over 80N. The launch structure will be partially reused but hydraulic actuation must be added in order to erect and retract the future launch structure of Gravitilab Aerospace Services, which will exceed the 80kg maximum weight.

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