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Title

Design and Testing of a Reefed Disk-Gap-Band Parachute of Huygens Heritage for Sounding Rocket Recovery

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Abstract

With over 15 years of research in all different areas of modern rocketry, Delft Aerospace Rocket Engineering (DARE) has pursued a multitude of sounding rocket projects. However, the increasing recovered mass and apogee goals of these missions motivate research on increasing reusability potential, considerably reducing costs and better adhering to sustainable development goals. The Supersized Parachute-Enabled Atmospheric Re-entry mission (SPEAR II) was started within the Parachute Research Group (PRG) of DARE to introduce the concept of reusability by developing a recovery system capable of landing the heaviest parts of DARE's flagship rockets, such as within the Stratos V project. The paper presents the design and wind tunnel testing of a reefed Disk-Gap-Band (DGB) parachute of Huygens heritage [1], used within SPEAR II. A DGB was chosen as it displays a balance between drag and stability at high altitudes, with a relatively simple design and low packing volume. Skirt reefing was also integrated to reduce the magnitude of shock loads experienced during parachute inflation.

The mission goals and requirements of the SPEAR II experiment are presented as input for the parachute's design requirements. Rationale on the selection of a Huygens heritage DGB over other parachute types and the common Viking heritage DGB is given. An overview of the geometric parameters after design and manufacturing process - including packing procedures - are presented. The benefits of reefing and its effect on shock loads from literature are briefly mentioned. This is followed by the design and integration of the reefing system used in the DGB. Various tests had been performed as a part of system verification. Tensile tests on suspension line samples were done to evaluate breaking strength and safety margins. Custom wire-cutters used for disreefing were tested on a component level. A scaled-down variant of the parachute, with the active reefing system integrated, was tested in a wind tunnel. Test results are provided in the form of drag performance, stability characteristics, and reefing performance. Finally, recommendations for future work on the DGB's development are noted.

References

[1] Underwood, J.C. (1995). Development testing of Disk-Gap-Band parachutes for the Huygens probe.