Advances in aerodynamic deceleration

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*The **Aerodynamic Decelerator Systems Technical Committee** focuses on decelerating manned and unmanned vehicles via parachutes, pararotors, and inflatable decelerators.*

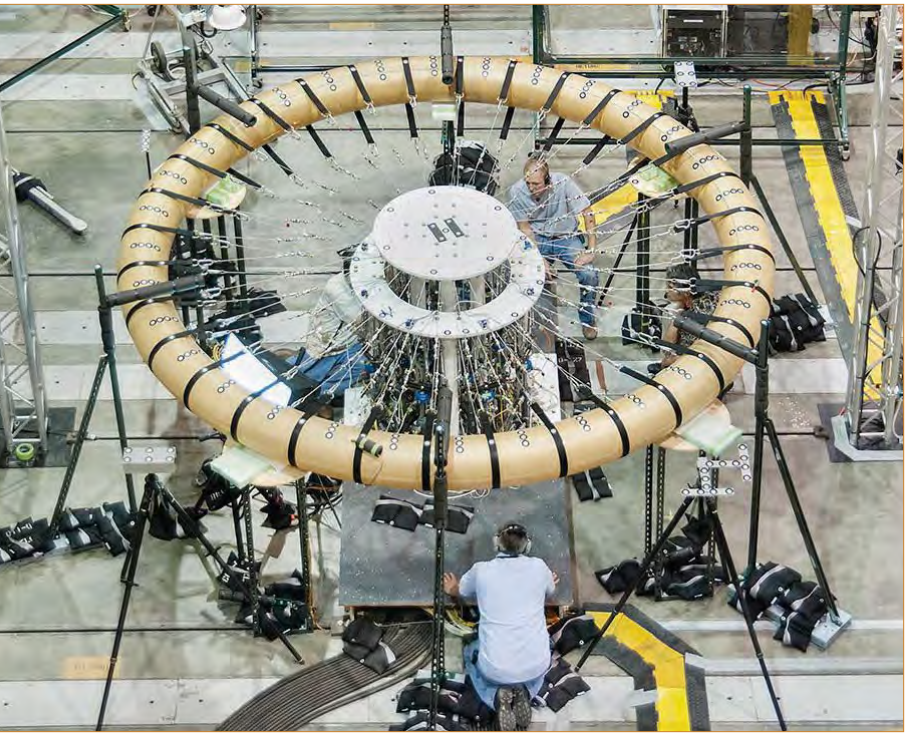
Development testing of Orion's **Capsule Parachute Assembly System** is nearly complete in anticipation of a critical design review in 2015. Highlights from the past year included two end-to-end tests in which the forward bay cover was jettisoned from the boiler plate before CPAS deployment. Testing was conducted in coordination with the Army Yuma Proving Ground in Arizona and the Air Force Material Command's 412th Test Wing. The CPAS team has also demonstrated the test capability to implement the low-velocity air drop technique from 35,000 feet mean sea level. This provides the ability to test at the nominal Orion deployment point for spacecraft entry from space. In addition, CPAS was integrated into the Orion Exploration Flight Test-1 capsule, scheduled for December.

The Army has placed an emphasis on maximizing the accuracy, reliability and survivability of autonomously guided cargo airdrops while minimizing cost; size, weight and power requirements; and component retrograde. The Natick Soldier Research, Development and Engineering Center has been developing guidance, navigation and control algorithms that employ visual data for use in GPS-denied or -degraded regions, avionics components and sensor networks, advanced wind measurement techniques, and autonomously actuated canopy vents for latitudinal and longitudinal system control. In addition, Natick and its partners fielded a **High Speed Container Delivery System**, which was first used in Afghanistan. The HSCDS can airdrop eight CDSs (up to 16,000 pounds) from an altitude of 250 feet at 250 knots indicated airspeed. That is significantly lower and faster than typical CDS airdrops of 500 feet and 140 knots, and will improve the survivability of aircraft and crews while providing a tighter dispersion and increased accuracy.

The Jet Propulsion Laboratory's **Low-Density Supersonic Decelerator** project, part of the Space Mission Technology Directorate, conducted the first high-altitude, supersonic flight tests of the next generation of aerodynamic decelerators for **future Mars missions**. Primarily a shake-out flight, the test lofted a 4.7-meter blunt-body aeroshell to an altitude of over 30 kilometers using a 34-million-cubic-foot balloon. The test vehicle was released from the balloon and accelerated to above Mach 4 and an altitude of 54 kilometers, where a 6-meter-diameter Supersonic Inflatable Aerodynamic Decelerator was deployed and used to slow the vehicle. The flight also saw the deployment and inflation of a large 4.4-meter-diameter trailing ballute at approximately Mach 2.7. A supersonic parachute was also deployed but was severely damaged during supersonic inflation.

NASA's Langley Research Center has also been working on the **Hypersonic Inflatable Aerodynamic Decelerator** project. An integrated 10-meter-class static load test was completed on the flexible thermal protection system, or F-TPS, integrated with the inflatable structure. Instrumentation checks were done for strap load cells and foil gauges. The team used instrumentation to measure the load carried by the F-TPS. Preliminary results indicated the F-TPS is carrying approximately 25 percent of the total load. Tests were conducted using a variety of inflation pressures and load cases.

NASA's Ames Research Center completed Arc Jet testing of woven carbon fabric joints for the Adaptable, Deployable Entry Placement Technology program. **ADEPT** is a mechanically deployable semi-rigid aeroshell entry system. Two-inch-wide joints were tested at 100 watts per square centimeter over a two-minute duration under a 100 pound-force per inch load. Both the carbon stitching and the carbon gore fabric survived the test. A resin-infused joint tested was found to be more resistant to layer loss. Additionally, there was excellent validation of pre-test CFD predictions with the Arc Jet test observations.



Technicians prepare the Hypersonic Inflatable Aerodynamic Decelerator for structural loads testing in the Flight Loads Laboratory at NASA's Armstrong Flight Research Center.

NASA