Aerodynamic decelerator systems

2009 was a very productive year for parachute development. Notable accomplishments include testing of the Mars Science Laboratory (MSL) parachute, the Ares I recovery system, and the Max Launch Abort System (MLAS), as well as significant work in the area of autonomous payload delivery.

The Ares I recovery system will require parachutes that are much larger and stronger than those used for the space shuttle.

The MSL parachute finished its final testing, successfully completing structural qualification and flight lot workmanship verification tests. The testing took place at the NASA Ames Full Scale Aerodynamics Complex 80 x 120-ft wind tunnel. The parachute was deployed at conditions that produced inflation loads 25% higher than the maximum expected flight limit load and included multiple inflations of the flight lot canopy. The final tally resulted in a single canopy withstanding 14 inflations at peak inflation loads ranging from 360 to 290 kN (81-65 klbf).

The Mars Science Laboratory parachute completed testing this year.

The Ares I solid rocket booster, which will launch the Orion crew exploration vehicle (CEV) following retirement of the space shuttle, is much heavier than the shuttle's booster and reenters the atmosphere at a much higher velocity; hence the parachutes must be larger and stronger. The 68-ft-diam drogue parachute will experience a load of 500,000 lb, while the three 150-ft-diam main parachutes will experience 300,000-lb loads. The final drogue parachute basic performance drop test was completed this year, along with a drop test of the clustered three main parachutes. The drogue drop test provided the drag area at various reefing ratios along with the corresponding opening loads and load factors. The cluster test provided the cluster degradation factor for the main parachute's drag area, as well as an observation of the parachute's deployment, inflation, and cluster interaction characteristics.

NASA's Engineering and Safety Center developed and tested MLAS as a risk-mitigation system should problems arise with Orion's launch abort design. The effort culminated in a highly successful July flight test. During the test, two mortar-deployed parachutes separated the coast skirt from the forward fairing, followed 3 sec later by two more mortar-deployed parachutes reorienting the fairing 180°, which placed the boilerplate CEV crew module (CM) in the heat-shield-first orientation. With the fairing stabilized, the boilerplate CM was released from inside the fairing. After a brief ride on two drogues, the boilerplate CM released its simulated forward bay cover and deployed four main parachutes.

This test demonstrated that the fairing could be successfully reoriented and the CM released without detrimental recontact. Thus it showed that the MLAS system is a viable concept should the baseline launch abort system encounter significant difficulties during development.

This year the Aerodynamic Decelerator Systems Center at the Naval Postgraduate School developed Snowflake, an autonomous networking aerial delivery system for a 3-lb payload. Networking capability allows target assignment and tracking from anywhere in the world through the Internet. Snowflake is currently being integrated with the Arcturus T-20 UAV, which will be able to carry up to 12 systems inside the payload bay and two payload containers under the wings.

Aerial delivery remains an increasingly critical and successful method of supply delivery for the military in all types of environments. Airdrops have nearly doubled every year since 2005 in Afghanistan, and are on track to exceed 30 million lb this year. The JPADS (joint precision airdrop system) family of autonomous air vehicle systems provides payload capability ranging from 1 to 42,000 lb, with most already demonstrated or in use. The largest precision airdrop demonstration ever held, conducted by the Army Natick Soldier Research, Development, and Engineering Center, took place in the U.S. October 19-22, 2008, allowing more than 500 U.S. and allied participants the opportunity to witness the capabilities and utility of precision airdrop systems.

by **Elsa Hennings**