Taking The Heat: Lockheed Martin Aeroshell To Protect NASA's Mars Science Laboratory On Descent Through Martian Atmosphere

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DENVER, July 26, 2012 /PRNewswire/ -- After a journey of 245 days across 352 million miles, the moment of truth for the Mars Science Laboratory (MSL) begins late in the evening of August 5 when the spacecraft roars into the Martian atmosphere, traveling at 13,200 miles an hour. The final seven minutes – the entry, descent and landing (EDL) – will determine the fate of the mission, and a perfect performance of the Lockheed Martin (NYSE: LMT) Space Systems aeroshell is absolutely vital to getting the Mars Curiosity Rover safely down on the sands of Mars.

VIDEO: "Protecting Curiosity": http://www.youtube.com/watch?v=OYsezwD_AIs

NASA's Mars Science Laboratory is the most ambitious Mars mission yet. With its Curiosity rover – built by the Jet Propulsion Laboratory (JPL) – the mission supports the Mars Exploration Program's strategy of "follow the water" and will have the science goals of determining whether the planet was ever habitable, characterizing the climate and geology of Mars, and preparing for human exploration.

The Lockheed Martin MSL aeroshell comprises a back shell and a heat shield. The back shell protects the Curiosity rover during cruise and descent, and provides structural support for the parachute and the unique descent stage, a system that will lower the rover to a soft landing on the surface of Mars. The biconic-shaped back shell is covered with a thermal protection system composed of the cork/silicone super light ablator (SLA) 561V that originated with the Mars Viking landers of the 1970s. Because of the extreme heat the unique entry trajectory through the atmosphere will create, the heat shield uses a tiled Phenolic Impregnated Carbon Ablator (PICA) thermal protection system. This will be the first time PICA has flown on a Mars mission.

"Our job during EDL is to protect Curiosity and its associated systems through an extremely dynamic and unforgiving environment and have it descend to the point where the sky crane can lower it gently on to the surface of Mars," said Rich Hund, aeroshell program manager for Lockheed Martin Space Systems Company's support of the NASA mission. "This aeroshell at nearly 15 feet across is the largest capsule we've ever flown and the design had to address the large size and weight of the rover along with the requirement for landing at a more-precise point on Mars. We look forward to hearing 'Curiosity has landed!'"

As the MSL spacecraft approaches the Mars atmosphere, an autonomous onboard computer program comprising over 500,000 lines of code will begin conducting commands to thrusters, systems and sensors that will culminate seven minutes later with a soft touchdown of Curiosity on the Martian surface.

Just prior to atmospheric interface at Mars, the aeroshell will turn so its heat shield faces forward along the direction of travel, then eject two 178-pound weights to shift the center of mass of the capsule. The shift will enable the capsule to generate lift as it flies through the atmosphere, allowing roll control and autonomous steering to guide it to a precise landing spot. Peak heating occurs about 75 seconds after atmospheric entry, when the heat shield temperature will reach about 3,800 degrees F. Peak deceleration occurs about 10 seconds later, with maximum deceleration forces possibly reaching as high as 15 Gs.

After MSL finishes its guided entry maneuvers, a few seconds before the parachute is deployed, the back shell jettisons another set of weights to shift the center of mass back to the axis of symmetry, rebalancing the spacecraft for the parachute portion of the descent. At an altitude of about seven miles and a velocity of about 900 miles per hour, the parachute – 51 feet in diameter – deploys about 254 seconds after entry. Twenty-four seconds later, the heat shield separates and drops away with the spacecraft at an altitude of about five miles and traveling at a velocity of about 280 miles per hour.

At heat shield separation, the Mars Descent Imager begins recording five images a second, continuously through landing, looking in the direction the spacecraft is flying. The rover and its descent-stage are still attached to the back shell on the parachute. Radar on the descent stage begins collecting data about velocity and altitude.

About 85 seconds after heat shield separation, the back shell, with parachute attached, separates from the descent stage and rover. Just a mile above the ground, and falling at 180 miles an hour, eight throttleable retrorockets on the descent stage begin firing. Decelerating abruptly to 1.7 miles per hour, nylon cords begin to spool out to lower the rover from the descent stage in the "sky crane" maneuver. The rover's wheels and suspension system, doubling as landing gear, rotate into place just before touchdown. When Curiosity senses touchdown, the connecting cords are severed and the descent stage flies out of the way, coming to the surface at least 492 feet from the rover's position.

Soon after landing, Curiosity's computer switches from EDL mode to surface mode. This initiates autonomous activities for the first Martian day on the surface of Mars, Sol 0. The time of day at the landing site will be mid-afternoon — about 3 p.m. local mean solar time at the destinationGale Crater.

During entry, descent and landing two other Mars spacecraft – Mars Odyssey and the Mars Reconnaissance Orbiter (MRO) – both built and operated for NASA by Lockheed Martin Space Systems – will monitor transmissions from the Mars Science Laboratory. Odyssey will receive telemetry directly from MSL and send it to Earth in a near-real time (light time delay is 13.8 minutes). MRO will also be recording the landing telemetry and will transmit it back to JPL an hour later. Also, MRO will attempt to take an image of the MSL descent with its HiRISE camera much the same way it did with the Phoenix Lander in 2008.

In addition to the aeroshell, technologists from Lockheed Martin's Information Systems & Global Solutions (IS&GS) have provided information technology (IT) support services to JPL's scientists, researchers and engineers throughout the MSL mission. During the entry, descent and landing event, the team from Lockheed Martin's JPL Desktop and Institutional Computing Environment (DICE) subcontract will be working alongside the JPL Mission Operations teams to provide mission-enabling technical and help desk support as needed and serve as the central reporting point to quickly address IT issues during the landing window.

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