As Space Shuttle Program Ends Lockheed Martin Looks Back With Pride And Forward With Promise

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SUNNYVALE, Calif., July 8, 2011 /PRNewswire/ -- The final mission of NASA's Space Shuttle program is underway, and Lockheed Martin (NYSE: LMT) Space Systems Company (LMSSC) has played a significant role from the very beginning. In addition to important shuttle systems that were a part of every flight, the company has had payloads on at least 30 missions that included spacecraft, satellites, instruments, telescopes, experiments, and various components.

"NASA's space shuttle has transformed Earth orbit from a frontier to a workspace—a place where humans live, build and create, where science thrives, where nations collaborate daily. For these extraordinary achievements, we salute the people on the ground and in space who have devoted their lives to this engineering marvel," said Joanne Maguire, executive vice president of Lockheed Martin Space Systems Company. "You have made history and laid the foundation for new voyages of discovery. We take enormous pride in being your partner, and look forward to working side by side to take America to new frontiers in space."

The Lockheed Martin-built systems that were part of every space shuttle mission include the External Tank (ET) and the Space Shuttle Thermal Protection. At 154 feet long and 27.6 feet in diameter, the ET is the largest element of the Space Shuttle and the structural backbone of the system. It has a propellant capacity of 537,000 gallons (1.6 million pounds) of cryogenic liquid hydrogen and liquid oxygen fuel that power the Space Shuttle Main Engines.

Space Shuttle Thermal Protection comes in two forms: shuttle tiles and Reinforced Carbon Carbon (RCC) panels. LMSSC in Sunnyvale, Calif. created and manufactured the reusable silica tiles that protected the Space Shuttle orbiters on every flight from the searing heat of re-entry through the Earth's atmosphere. The tiles are such poor heat conductors that they can be held in a bare hand while still red-hot. The original contract was to provide tile material for four orbiters–*Columbia*, *Challenger*, *Discovery* and *Atlantis*. Following the loss of *Challenger* in 1986, Lockheed Martin provided a tile set for *Endeavour*.

Each time the Space Shuttle Orbiter makes its fiery re-entry through the Earth's atmosphere, the RCC panels protect the vehicle's nose section, wing leading edges and chin panel against metal-melting temperatures approaching 3,000 degrees Fahrenheit. The RCC was also developed by Lockheed Martin.

The loss of the Space Shuttle *Columbia* on February 1, 2003, from damage sustained to one of its RCC panels by falling foam from the External Tank, necessitated a way to repair damage to Space Shuttle Thermal Protection on-orbit. The LMSSC Advanced Technology Center annex in Denver provided a solution. The material developed can be used by spacewalking astronauts to repair cracks and nicks in the tiles, utilizing a chemical process that uses a silicone condensation reaction to create a silicone rubber, which is pyrolized during reentry to a ceramic state. The material is an ablator because the ceramic chars on reentry to dissipate heat and protect the orbiter from high temperatures. The Shuttle Tile Repair Kit has been carried on every post-Columbia mission, but fortunately has not been needed.

Lockheed Martin payloads carried on individual shuttle mission are numerous, and fall into several categories. Solar systems exploration missions launched from the shuttle include the *Magellan* mission to Venus–for which LMSSC in Denver built the spacecraft and provided mission operations. Denver LMSSC personnel also built a key component of the attitude and articulation control system electronics that controlled the *Galileo* spacecraft on its mission to Jupiter, and provided three of the six scientific instruments on the probe. The *Galileo* radioisotope thermoelectric generator (RTG) was built at the LMSSC facility in Valley Forge, Pa. Valley Forge also manufactured the general-purpose heat source, the radioisotope thermoelectric generator (GPHS-RTG), which provided electrical power to *Ulysses,* the NASA/ESA mission that studied the heliosphere – the enormous "bubble" blown by the Sun's solar wind into the interstellar medium – that marks the boundaries of our solar system.

The *Hubble Space Telescope* (HST), NASA's premier space observatory–designed and built at LMSSC in Sunnyvale–was carried to space on the shuttle in 1990, and serviced and upgraded by spacewalking shuttle astronauts in 1993, 1997, 1999, 2002 and 2009. Company personnel have also helped NASA manage the day-to-day spacecraft operations of the telescope, and provided extensive preparation and training for the telescope servicing missions. Hubble, still making spectacular discoveries 21 years after launch, made its one millionth

science observation on July 4, 2011.

Communications satellites built at Lockheed Martin facilities in Valley Forge, Pa. and East Windsor, N.J. were deployed into space on four shuttle missions in 1985, 1986 and 1993. Solar array technology developed at the Sunnyvale facility, and later used on the *International Space Station* (ISS) was tested during a flight experiment in 1984, and delivered to the Russian *Mir* space station in 1996.

The ISS solar arrays, designed and built at the Space Systems facility in Sunnyvale, are the largest deployable space structure ever built and are by far, the most powerful electricity-producing arrays ever put into orbit. They were launched to the station on four shuttle missions in 2000, 2006, 2007 and 2009. In addition, the company built two solar array rotary joints that maintain the solar arrays in an optimal orientation to the Sun while the entire space station orbits the Earth once every 90 minutes. The company also built two thermal radiator rotary joints that maintain the thermal radiators in an edge-on orientation to the Sun that maximizes the dissipation of heat from the radiators into space. The thermal radiators themselves were also built by Lockheed Martin. The Sunnyvale facility also built two Trace Contaminant Control Subassembly units–advanced air processing and filtering systems that ensure that over 200 various trace chemical contaminants, generated from material off-gassing and metabolic functions in the ISS atmosphere, remain within allowable concentration levels.

Lockheed Martin in Denver built the Manned Maneuvering Unit (MMU), a vehicle that enabled astronauts to fly untethered, away from the shuttle, to perform a variety of extravehicular activities, such as satellite retrieval, science investigations and observations, in-space construction, and rescue operations. The MMU was used on three shuttle flights in 1984.

Solar science was the focus of two shuttle flights. The crippled Solar Max satellite was captured from orbit by the shuttle robot arm in 1984. Spacewalking astronauts working in the payload bay were able to replace a faulty attitude control system, and replace an electronics box on the satellite's coronagraph. Because of the successful demonstration of on-orbit satellite repair capability, another Solar Max instrument–the Soft X-ray Polychromator–built at the Lockheed Martin Advanced Technology Center (ATC) in Palo Alto, Calif., was able to resume its observations, and the Solar Max Mission continued until 1989. In 1985, Spacelab 2 was lofted into orbit, and with it yet another Sun-watching telescope developed at the ATC. Dr. Loren Acton and his team in Palo Alto designed and built the Solar Optical Universal Polarimeter (SOUP) instrument, and Acton operated it in orbit as a payload specialist.

During the final shuttle flight, STS-135, *Atlantis* astronauts will install NASA's Robotic Refueling Mission (RRM) module on the outside of the *International Space Station*. The RRM will demonstrate and test the tools, technologies and techniques needed to robotically refuel and repair satellites in space. Lockheed Martin is providing systems and discipline engineering support to NASA's Goddard Space Flight Center to develop and execute this demonstration. RRM will use a module and specialized tools to robotically demonstrate refueling and repair tasks in orbit and verify robotic servicing capabilities. These will include locating, accessing and uncapping valves and transferring simulated liquid fuel.

LMSSC is currently developing the *Orion Multi-Purpose Crew Vehicle* (MPCV) that will serve as the nation's next generation spacecraft to take humans far beyond low Earth orbit to multiple destinations throughout our solar system. LMSSC is working closely with NASA to achieve Orion/MPCV initial crewed operations by 2016, consistent with the NASA Authorization Act of 2010.

Headquartered in Bethesda, Md., Lockheed Martin is a global security company that employs about 126,000 people worldwide and is principally engaged in the research, design, development, manufacture, integration and sustainment of advanced technology systems, products and services. The Corporation's 2010 sales from continuing operations were $45.8 billion.

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Additional information and images of Lockheed Martin involvement
with the Space Shuttle program can be found at:

http://www.lockheedmartin.com/ssc/spaceshuttle/spaceshuttle/

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