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2014 IN REVIEW

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Space environment milestones

by Brian O'Connor and the Space Environmental Systems Program Committee

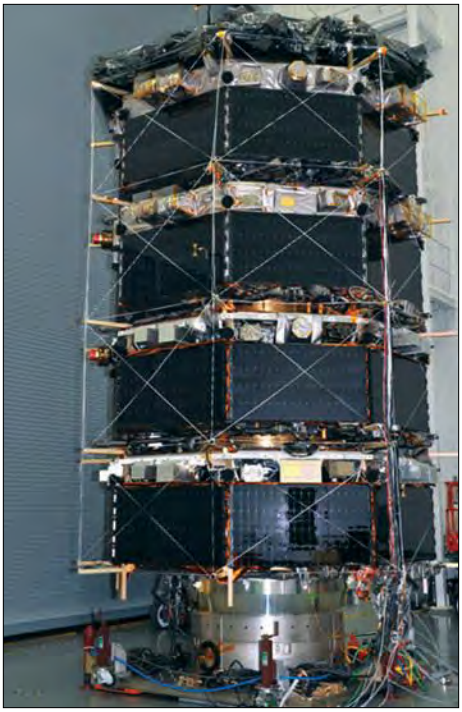
*The **Space Environmental Systems Program Committee** focuses on environmental and thermal control technologies for aircraft, spacecraft and exploration missions.*

Notable accomplishments this year in the implementation of environmental and thermal control in aerospace systems included many large projects meeting major review and integration milestones.

In July, NASA's Goddard Space Flight Center completed thermal vacuum testing of the **Magnetospheric Multiscale Mission** observatory satellites at the Naval Research Laboratory. The primary goal was to demonstrate repeated system-level performance at the extremes of the flight predicted temperatures. Vertex Aerospace, contracted by Goddard, developed the thermal design and predicted the flight and test temperatures. In addition, the project designed and implemented 1-Wire temperature sensor technology, which reduced the number of wires from hundreds to just 18. The test demonstrated that the workmanship of the observatories was acceptable. The post-test correlated thermal model verified the effectiveness of the thermal design elements, including surface coatings, multilayer insulation, heater circuit capacities and power duty cycles. The project is scheduled to launch from Kennedy Space Center in March.

ESA

European Space Agency's ExoMars Rover.



NASA/Barbara Lambert

The four Magnetospheric MultiScale Observatory satellites are shown fully stacked without covers.

The **James Webb Space Telescope** achieved a major milestone this year when the **sunshield** was stacked and unfurled in a cleanroom at a Northrop Grumman facility in Redondo Beach, California. The telescope will rely on the sunshield to keep the optics cold. It is about the length of a tennis court when deployed but must be folded around the telescope before launch. Composed of five layers of thin membrane, the sunshield must unfurl reliably in space to precise tolerances to allow the telescope optics to operate at temperatures of around 50 kelvins (minus 370 degree Fahrenheit). The telescope is scheduled to launch in 2018.

The European Space Agency's **ExoMars** mission reached several major hardware delivery milestones this year and is well on its way to a January 2016 launch. The mission consists of an orbiter and a stationary lander. Manufacturing of the back and front heat shield structures was completed by Thales Alenia Space of France and Airbus Defence and Space of Spain, respectively. Both sections were delivered to Airbus Defence and Space in France and 180 cork tiles were bonded to the thermal protection system. Thales Alenia Space also begun integration of the avionics on the lander in Italy. This includes qualifying and installing thermal capacitors needed for the thermal control of some high dissipating avionic units.

ESA's **Orion Service Module** completed its preliminary design review this year. The module will provide primary power, expendable supplies, including water and oxygen, propulsion, attitude control and thermal control to the Orion Multi-Purpose Crew Vehicle. The review inspected the environmental control and life-support system architecture in terms of mass, power and safety aspects of a crewed system. This led, in particular, to improvements in the robustness and reliability of the thermal control subsystem and the consumables subsystem, while minimizing mass.

The expanding field of smallsats, cubesats and microsats is providing an economical platform to test new **thermal control technologies**. For example, the Japanese micro-satellite Hodoyoshi-4, which launched in June, has a number of new technologies that were demonstrated to work in space. One technology is a heat storage panel that moderates temperature changes around the phase-change temperature of a chosen phase-change material, such as eicosane, encased in a carbon fiber reinforced polymer. Another heat storage technology uses a solid-solid crystalline structure change to store the heat. The material could potentially be used in the structure of a spacecraft.