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Roundup

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NASA's Mars-bound mini-propellant plant

For 11 days last March, JSC was the site of the most Mars-like place on Earth.

To be exact, a 5-foot-diameter, 5-foot-long, cylindrical vacuum chamber inside Building 353 was configured to simulate Mars.

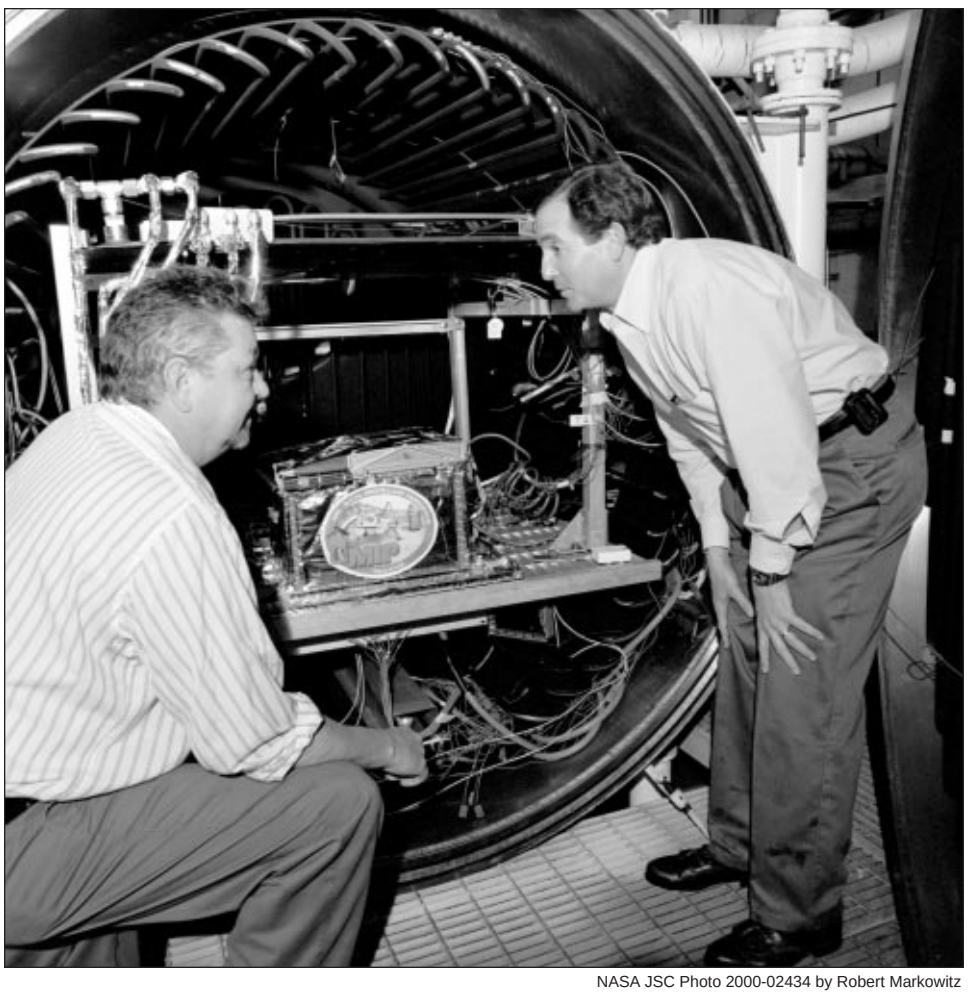
The atmosphere inside the chamber at the Engineering Directorate's Energy Systems Test Area was made up of 95 percent carbon dioxide, 3 percent nitrogen, 2 percent argon, and zero percent oxygen. The atmospheric pressure was approximately 1/100 of that of Earth, and the day-night temperature ranged between –88° Centigrade (–126° Fahrenheit) to –23° Centigrade (–10° Fahrenheit). Even the length of a day was adjusted to be 24 hours and 40 minutes to mimic the rotation of Mars.

Why duplicate Mars so accurately? Because a JSC payload is to fly on the next robotic lander to Mars and this payload needed to be thoroughly tested. JSC's Mars In-situ-propellant-production Precursor will test the feasibility of using the thin Mars atmosphere to produce oxygen for breathing air and rocket propellants. It will also contain a variety of other experiments to measure the effects of the dusty Mars atmosphere on solar cells and heat radiators.

This "living off the land" project, also known as "MIP," had been working against a schedule to deliver its flight hardware for integration onto the robotic Mars Surveyor Lander this summer, with a planned launch to Mars on a Delta II expendable launch vehicle in April of 2001. In light of that timetable, the JSC team building the experiment began rigorous Martian environmental testing in March.

"The loss of the Mars Polar Lander last December 3 has impacted our launch date," said MIP Project Manager Jim Ratliff of the Biomedical Hardware Development and Engineering Office. "The design of the 2001 Lander is very similar to the Mars Polar Lander. Consequently, NASA Headquarters has decided not to launch this lander during the 2001 opportunity."

"Despite the launch delay," Ratliff said, "the MIP Team has to press ahead on nearly the original schedule in order to stay within our budget constraints. Once qualification testing is complete, we can then focus on delivering the flight unit. This program has been 'test intensive,' but this is the first time hardware will produce a resource on another planet, and we want to make sure the design is robust enough to work remotely in the harsh Martian environment."



NASA JSC Photo 2000-02434 by Robert Markowitz

MIP Qualification Unit being installed inside Mars Simulation Chamber by Lockheed Martin Electrical Team Leader Jim Wines (kneeling) and MIP Principal Investigator David Kaplan.

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>
> – David Kaplan

"The concept is to use the resources on Mars to reduce the amount of materials that need to accompany a human mission …to 'live off the land,'" said Principal Investigator David Kaplan of JSC's Exploration Office. "MIP will selectively absorb and compress carbon dioxide from the Martian atmosphere; produce propellant-grade, pure oxygen; test advanced photovoltaic solar cells for energy production; test techniques to combat the settling of airborne dust onto solar arrays; and test thermal radiators. In particular, producing oxygen using materials readily available on Mars would be an important step toward reducing the costs and risks of an eventual human exploration mission to Mars."

MIP will be the first hardware to use the indigenous resources of a planet or moon. Its successful operation will pave the way for future robotic and human missions to rely on propellants produced using Martian resources as feedstock.

The qualification unit began environmental testing on March 15 and finished March 29. Initial tests qualified the thermal performance using temperature extremes expected during the 11-month-long cruise to Mars. Thermal vacuum testing was followed by 10 continuous days of Mars surface environment simulations, including worst-case cold, worst-case hot, and normal temperature profiles. These tests exercised all operational modes of the hardware and software. Operations were conducted in a "hands off" manner by sending commands that scheduled activities for the next 48 hours, as will be done on the Mars surface. Verifying that MIP could operate remotely and return the proper experiment data was an important part of this test.

The experiment's Oxygen Generation Subsystem, which is led by Scott Baird of the Energy Systems Division, worked well in three test runs. For each run, oxygen was produced for 3 to 4 hours. The heart of the oxygen generation is a wafer-thin, solid-oxide ceramic disk made of zirconia about the size of a small cookie. It is sandwiched between two platinum electrodes and heated to 750° Centigrade (1380° Fahrenheit). When carbon dioxide is fed to this unit, the zirconia cell "cracks" the carbon dioxide into carbon monoxide and oxygen. Only the oxygen can penetrate through to the other side of the disk; the carbon dioxide and carbon monoxide gases are stopped in their tracks.

Testing also verified the capability of the JPL-provided Mars Atmosphere Acquisition and Collection experiment to absorb an abundant supply of carbon dioxide from the atmosphere and to supply this carbon dioxide as feedstock.

Two experiments provided by the Glenn Research Center – a solar cell experiment called the Mars Array Technology Experiment and a dust mitigation experiment called the Dust Accumulation and Repulsion Test – also worked well.

"We are currently tracking two issues as a result of the testing," said MIP Deputy Chief Engineer Howard Flynn of the Energy Systems Division.The causes for a pinhole leak in a bellows and an open circuit in a radiator heater have been found and are being corrected.

"Both experiments are scheduled to be returned to JSC in early June where they will be reintegrated and retested," Flynn said. "After successful re-testing, the MIP Qualification Unit will continue its qualification testing with a pyroshock test to take place at Lockheed Martin Astronautics."

When the flight hardware is completed later this summer, it will be placed in environmentally controlled storage until early 2002, which is when the Lander is scheduled to begin payload integration activities.

"We are convinced that the successful operation of MIP will significantly advance the critical exploration technology of producing important consumables on Mars from Martian resources," said Ratliff. ■

Space station trailers on tour this summer.

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Dealing with stress when the pressure is on.

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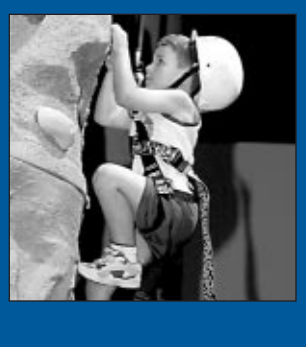

Extreme sports at Space Center Houston.

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