Spacecraft enters orbit around Mars

Probably with RTG's for instrument protection and power but this text does not say that.

Spaceflight Now
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After a seven-month voyage from Earth, NASA's Mars Reconnaissance Orbiter successfully fired its main engines for 27 minutes today, slowing the craft by some 2,200 mph and putting it into a near-perfect elliptical orbit around the Red Planet.

The engines started on time at 4:24 p.m. and were running normally when MRO disappeared behind Mars as viewed from Earth. As expected, the spacecraft remained out of contact for a tense half hour and it wasn't until contact was re-established at 5:16 p.m. that nervous mission managers knew the $720 million mission had survived.

"All stations, we have one way (communications)," an engineer reported when the signal re-appeared.

Flight controllers at the Jet Propulsion Laboratory in Pasadena, Calif., erupted in cheers, hugs and applause as the spacecraft emerged from behind Mars and back into radio contact with Earth.

"We're there. We're there!" said an engineer, with evident relief.

"Oh, look, it's right on the money," another marveled.

"Right on the money! Look at that! Right on the money!"

It took another few minutes to confirm the craft was actually in orbit and that the main engines had, in fact, fired long enough to prevent a flyby. If the Mars orbit insertion burn had been too short by just a few minutes, the spacecraft would have sailed past Mars and into a useless orbit around the sun. But the solar-powered satellite operated flawlessly throughout the critical maneuver.

"All stations on MRO coord, this is Nav MSA. We have two-way doppler and MRO is in orbit around the planet Mars," the navigation officer reported, touching off another round of applause.

The rocket firing put the craft in an elliptical orbit with a low point of 264.5 miles and a high point of about 28,000 miles. The period of the first orbit was estimated to be 35.5 hours, as opposed to the predicted value of 35.4 hours. The MOI burn was designed to reduce the spacecraft's velocity by 2,237.6 mph. The actual result was within 0.4 mph of the desired amount.

"We noticed during the burn we appeared to be underperforming by about 2 percent," said Howard Eisen, MRO flight systems manager. "But the vehicle was smart enough to take care of itself, it actually burned 33 seconds longer to make up the difference. That's why we came in so exact."

Said Jim Graf, MRO project manager: "It's great to be on the flip side of MOI!"

"Today was picture perfect," he said. "As a matter of fact, I thought today was a simulation because we came so close to being right on. ... It's a great feeling to have another spacecraft orbiting around Mars. It's going to re-write the science textbooks."

Approaching Mars from below, the Mars Reconnaissance Orbiter (MRO for short)pressurized its propulsion system at 3:50 p.m., a critical milestone and the point where NASA's Mars Observer spacecraft failed in 1993. After re-orienting, MRO's flight computer fired up the craft's six 38-pound-thrust main engines main engines at 4:24 p.m. to begin the critical braking manoeuvre.

"Burn, baby, burn!" an engineer exclaimed when telemetry showed the rocket firing was underway.

About 21 minutes into the rocket firing, MRO disappeared behind the limb of Mars and flight controllers at JPL lost contact with the spacecraft. Thirty minutes later - 25 minutes after the engines were programmed to shut down - MRO emerged from behind Mars.

Using a variety of clever tracking techniques, controllers knew MRO was on the proper course going into today's braking maneuver. And unlike any previous robotic mission, MRO's computer had the ability to reboot itself in the event of a major problem and restart the rocket firing on its own. But nothing went wrong and NASA's latest Mars mission put a major challenge behind it.

Flight controllers will spend the next six to seven months slowly lowering the high point of MRO's orbit by making repeated low-altitude passes through the planet's extreme upper atmosphere. The idea is to use friction with the Martian atmosphere to provide the energy necessary to achieve a roughly circular polar orbit.

To guard against overheating the costly spacecraft, flight controllers will proceed very cautiously. Beginning in late March or early April, the low point of the orbit will be slowly reduced to around 62 miles. It will be raised, or "walked out," later, with the ultimate goal being a roughly circular orbit with a high point of at most 199 miles and a low point as close as 158 miles to the surface.

"The first part is there are some practice runs where we just test out the environment, the engines, in this configuration," said project scientist Richard Zurek. "It's like stepping into the pool when you're not sure about the temperature of the water, you put your toe in first and gradually go in. So we go through a series of altitudes to 200 kilometers (124 miles) and then we'll start stepping down from there. It's not until you get to around 160 kilometres (100 miles) of the surface of the planet that you're really going to start feeling the effects of the atmosphere and even then we've got plenty of margin against overheating.

"So you see what that density is and now you've got your first point correlating altitude with what you're seeing. As we get to the lowest altitude, we'll take smaller steps. So step by step, that's what we call the walk in."

During peak aerobraking, Zurek said, the atmospheric forces acting on the spacecraft will be roughly comparable to what one would feel sticking a hand out a car window at a speed of about 40 mph. But it is heat, not the aerodynamic forces that pose the biggest concern. Engineers do not want MRO to experience anything higher than about 340 degrees Fahrenheit.

"It's kind of a high wire balancing act," Zurek said. "You want to go deep, and in a reasonable amount of time, to get down to the orbit you want and yet you're not going so deep that you're going to overheat some component of the spacecraft."

Once aerobraking is complete, science operations will begin in earnest.

"In 1964, Mariner 4 flew by Mars taking a stark set of 24 images showing a surprisingly barren, cold and dry planet," Michael Meyer, NASA's lead Mars scientist at agency headquarters, said during a recent news conference. "Over 40 years later, we're now poised to collect more data than all the previous missions combined. MRO ... is expected to return 34 terabytes of information. This is about as much information as in a video store. I can only imagine the number of exciting things we're going to find on the planet.

The Mars Reconnaissance Orbiter began its journey Aug. 12, 2005, with launch atop a Lockheed Martin Atlas 5 rocket. The spacecraft is the latest in a series of robotic probes designed to explore Mars at ever-increasing levels of detail.

Equipped with a suite of sophisticated cameras and other instruments, MRO will sniff out underground ice deposits, map the red planet's geology with unprecedented clarity and monitor its tenuous, dusty atmosphere.

It also will serve as a communications satellite, relaying measurements and observations from future Mars landers while using its own ultra-high-resolution camera and other instruments to identify possible landing sites.

With six sophisticated instruments, including a giant 1.2-gigapixel camera capable of photographing objects as small as a kitchen table, the Mars Climate Orbiter is expected to beam back three to four times the combined output of two NASA spacecraft already in orbit around Mars, along with NASA's Cassini Saturn orbiter and the old Magellan Venus orbiter.

"Since Mariner 4, we've learned that Mars was once warmer and wetter," Meyer said. "But when, and for how long, remains to be the central question in our understanding of the biological potential of Mars. MRO will be multitasking. It's going to be a weather satellite, it's going to be a surveyor, able to identify geological features, minerals, the subsurface structure, It's going to be a communications relay and a guide to the next decade of exploration. The instrument capabilities are unprecedented.

"So after the hair-raising Mars orbit insertion and several months of aero-braking, MRO will start the science orbit and acquire a tremendous amount of data. We will be well placed in finding exciting new features on Mars, places to go and the wherewithal to unveil the past and potential future of Mars."