Mariner Mars ’71 Description

The Mariner Mars ’71 mission planned to launch two spacecraft, Mariners 8 and 9, to orbit Mars. Mariner 8 was lost at launch on 8 May 1971. Mariner 9 launched successfully on 30 May 1971 and went on to complete its mission.

# Mission Overview

On November 14, 1971, Mariner 9 became the first spacecraft to orbit another planet. Six experiments were carried as part of the science payload: television, ultraviolet spectrometer, infrared spectroscopy, infrared radiometry, S-band occultation, and celestial mechanics. Two experiments (S-band occultation and celestial mechanics) utilized the radio telemetry subsystem to derive data; the other required specially developed instruments, mounted, and boresighted to each other, on the spacecraft’s scan platform. Pre-launch mission planning encompassed two separate, but complementary, missions. The orbit of each spacecraft was optimized to match the corresponding objective. The mapping mission was designed with an Earth-synchronous orbit (about a 12-hr periods) to maximize antenna utilization, or communications efficiency. For maximum surveillance of an area, it was designed with a steep inclination (80 degrees) to the equatorial plane of Mars. The dynamic objective dictated a Mars-synchronous (or sub-synchronous) orbit and a lower (50 degree) inclination for closer observations of specific areas. The plans for the two missions were in detailed stages of development on May 9, 1971 when Mariner 8 was lost because of guidance difficulties in the second stage of the launch vehicle. It was determined that an orbit for a single-spacecraft mission could be developed to meet all basic mission and specific science objectives. A single-spacecraft plan, involving an inclination of 65 degrees, a period of about 12 hours, a periapsis altitude of 1350 Km, and an arrival date of November 14, 1971, was evaluated and formalized in 2 weeks.

## Mariner 9 Statistics

Total mission 516 days

Required minimum useful orbital lifetime 90 days

Actual useful orbital lifetime 349 days

Distance from Earth to Mars on 10/27/72 383,675,000Km

Commands received by Mariner 9 45,960

TV pictures received of Mars and its satellites 7329

TV shutter actuations 14,004

Required minimum mapping coverage 70% of planet

Actual mapping coverage obtained 100% of planet

Science data received from Mariner 9 54 billion bits

## Mariner 9 Firsts

1. Orbit another planet
2. Detail observation of Martian Atmospheric Changes
3. Complete mapping of another planet
4. Detail observations of satellites of another planet
5. Observation by spacecraft of receding polar cap

## Mariner 9 Discoveries

1. Tectonic action on Mars (Crust movement)
2. Existence of volcanoes and lava flows
3. Evidence of past fluid flow
4. Eolian activity (wind erosion and deposition)
5. Rough gravity field
6. Triaxiality of Mars
7. Evidence of process of differentiation of Mars similar to that of Earth
8. Permanent residual polar cap

On October 28, 1972, Mariner 9 ran out of attitude control gas and was commanded to be silent for the final time. It is estimated that Mariner 9 will remain in Mars orbit for more than 50 years.

# Mission Phases

## CRUISE

On June 5th, a planned trajectory correction was made. Martian ephemeris data and spacecraft tracking calculations were determined with such accuracy that no other midcourse corrections were necessary during the 167 day flight to Mars. Other events during cruise were scan calibration no. 1 on October 1, scan calibration no. 2 on October 8, Mars TV calibration on November 8 and November 9.

Spacecraft Id : MR9

Target Name : MARS

Mission Phase Start Time : 1971-05-30

Mission Phase Stop Time : 1971-11-14

Spacecraft Operations Type : ORBITER

## LAUNCH

Mariner 9 was successfully launched from Cape Kennedy, Florida at 6:23 PM EDT. The Centaur-Mariner 9 separation occurred at 6:36 PM EDT.

Spacecraft Id : MR9

Target Name : MARS

Mission Phase Start Time : 1971-05-30

Mission Phase Stop Time : 1971-05-30

Spacecraft Operations Type : ORBITER

## ORBITAL

The 1398 Km periapsis altitude of the insertion orbit was accurate to with 50 Km from the aiming point, and the initial period of 12 hr and 34 min was within seconds of the time desired for the insertion orbit. The non-synchronization with Earth provided the timing slip until coincidence of the Goldstone 64-m antenna zenith position and orbit periapsis was obtained and a trim maneuver “locked” the two into synchronization. On November 16, the spacecraft’s orbital period was changed by more than 30 min by a 6-sec firing of the rocket engines. However, because of the previously unknown gravity-field variation of the planet the average orbital period was found to be slightly shorter that the 11:58:52 planned, gradually changing the time relationship of periapsis to the view period of the 64-m antenna at Goldstone, California, which would eventually affect data playbacks. On December 30 (revolution 94), a second trim maneuver adjusted the orbital period, correcting periapsis-passage timing with the view period of the 64-m antenna. This new orbit established a higher periapsis altitude, which provided a broader area coverage for each television picture, thus requiring fewer pictures to complete the desired mapping of 70% of the surface during the standard 90-day mission. The broader area coverage for each pictured resulted in a corresponding loss of surface resolution. About 122 days after orbit insertion, the pointing direction of the spacecraft’s high-gain antenna drifted off of Earth, and communications became more difficult. A high-gain antenna maneuver (HGAM) of the spacecraft became necessary to point the antenna to Earth. On October 27, 1972, telemetry data indicated that the spacecraft was no longer capable of holding the fixed attitude and, as the last battery power was being used, a final command was sent to stop transmitting. The slowly tumbling Mariner 9 will remain in orbit for a minimum of 50 years before it enters the atmosphere of Mars, disintegrates, and falls to the surface.

Spacecraft Id : MR9

Target Name : MARS

Mission Phase Start Time : 1971-11-14

Mission Phase Stop Time : 1979-10-27

Spacecraft Operations Type : ORBITER