101)

Venera 5

Nation: USSR (57)
Objective(s): Venus landing
Spacecraft: 2V (no. 330)
Spacecraft Mass: 1,130 kg
Mission Design and Management: GSMZ Lavochkin
Launch Vehicle: 8K78M
Launch Date and Time: 5 January 1969 / 06:28:08 UT
Launch Site: NIIP-5 / launch site 1
Scientific Instruments:

Lander:
1) radio altimeter
2) aneroid barometer
3) eleven gas analyzer cartridges
4) two resistance thermometers
5) ionization densitometer
6) photoelectric sensors

Bus:
1) magnetometer
2) cosmic-ray counters
3) charged-particle traps
4) ultraviolet photometer

Results: Veneras 5 and 6 were two identical spacecraft designed to penetrate Venus's atmosphere and transmit a variety of scientific to Earth during descent. Both spacecraft were targeted to reach Venus only a day apart, thus allowing some cross-calibration of data. Although both spacecraft used a similar bus-lander system as the 1V-type spacecraft (flown as Venera 4), the two new landers (each weighing 405 kilograms) were designed to endure g-loads as high as 450 (as opposed to 300 for their predecessors). The landers also used smaller parachutes for descent, allowing the probes to descend faster through the atmosphere to increase chances of operating close to the surface. After performing seventy-three communications sessions with ground control and completing one midcourse correction on 14 March 1966, Venera 5 approached the dark side of Venus on 16 May 1969 and detached its lander, whose speed reduced from 1,100.17 meters per second to 210 meters per second after it hit the Venusian atmosphere at 06:01 UT. One minute later, controllers reestablished contact with the lander and began receiving transmitted data on pressure, temperature, and composition of the Venusian atmosphere for 53 minutes. Contact was lost at an altitude of about 24 to 26 kilometers when the pressure exceeded 26.1 atmospheres. Impact coordinates were 3° south latitude and 18° longitude. Information extrapolated from Venera 5's data suggested that ground temperature and pressure at the Venusian surface were 140 atmospheres and 530°C, respectively.

102)

Venera 6

Nation: USSR (58)
Objective(s): Venus landing
Spacecraft: 2V (no. 331)
Spacecraft Mass: 1,130 kg
Mission Design and Management: GSMZ Lavochkin
Launch Vehicle: 8K78M
Launch Date and Time: 10 January 1969 / 05:51:52 UT
Launch Site: NIIP-5 / launch site 1
Scientific Instruments:

Lander:

1) radio altimeter
2) aneroid barometer
3) eleven gas-analyzer cartridges
4) two resistance thermometers
5) ionization densitometer
6) photoelectric sensors

Bus:

1) magnetometer
2) cosmic-ray counters
3) charged-particle traps
4) ultraviolet photometer

Results: Identical to Venera 5, Venera 6 reached Venus after performing sixty-three communications sessions with Earth and one midcourse correction at a range of 15.7 million kilometers from Earth on 16 March 1969. Its 405-kilogram lander separated from the main bus 25,000 kilometers from the planet and entered the Venusian atmosphere at a velocity of 11.17 kilometers per second at 06:05 UT on 17 May 1969. The Venera 6 capsule transmitted data for 51 minutes before contact was lost, probably at an altitude of about 10 to 12 kilometers. Pressure was similar at the time to that measured by Venera 5 at a much higher altitude, indicating that Venera 6 may have come down over a mountain or high plateau. Landing coordinates were -5° latitude and 23° longitude. Results from the Venera 5 and 6 missions, published by the Soviets in March 1970, seemed to confirm and sharpen earlier findings from Venera 4. The two new spacecraft found that Venus's atmosphere was composed of roughly 93 to 97 percent carbon dioxide (the remainder was split among nitrogen, oxygen, and inert gases). Data from Venera 6 suggested that the ground pressure was about 60 atmospheres and ground temperature was about 400°C. This compared with Venera 4's readings, which indicated pressure at 75 atmospheres and temperature at 500°C.

103)

no name / [Zond]

Nation: USSR (59)
Objective(s): circumlunar flight
Spacecraft: 7K-L1 (no. 13L)
Spacecraft Mass: c. 5,375 kg
Mission Design and Management: TsKBEM
Launch Vehicle: 8K82K + Blok D (Proton-K no. 237-01)
Launch Date and Time: 20 January 1969 / 04:14:36 UT
Launch Site: NIIP-5 / launch site 81L
Scientific Instruments: unknown
Results: This was the sixth attempt at a robotic circumlunar flight in support of the L1 piloted lunar program and the first after the resounding success of the American Apollo 8 in December 1968. The Proton launch vehicle lifted off on time, and first-stage operation was nominal. However, during second-stage firing, one of the four engines of the stage mysteriously switched off at T+313.66 seconds. The other engines continued firing, but subsequently, the primary third-stage engine also switched off during its firing sequence at T+500.03 seconds due to a breakdown in the main pipeline feeding fuel to the fuel gas generator. After a near-ballistic flight, the L1 payload landed near the border between the USSR and Mongolia.

104)

no name / [Luna]

Nation: USSR (60)
Objective(s): lunar roving operations
Spacecraft: Ye-8 (no. 201)
Spacecraft Mass: c. 5,700 kg
Mission Design and Management: GSMZ Lavochkin
Launch Vehicle: 8K82K + Blok D (Proton no. 239-01)
Launch Date and Time: 19 February 1969 / 06:48:15 UT
Launch Site: NIIP-5 / launch site 81P
Scientific Instruments:

1) imaging system (two low-resolution TVs and four high-resolution photometers)

2) x-ray spectrometer
3) penetrometer
4) laser reflector
5) radiation detectors
6) x-ray telescope
7) odometer/speedometer

Results: The Ye-8 represented the "third generation" of Soviet robotic lunar probes. The basic Ye-8 comprised a lander stage (the "KT") topped off by an eight-wheeled, remote-controlled lunar rover (the "8YeL") for exploring the Moon's surface. Essentially a pressurized magnesium alloy container on wheels, the 8YeL was designed to operate over a period of three lunar days (roughly three Earth months) and collect scientific data from various points on the lunar surface. This first attempt to put the rover on the Moon was a complete failure. At T+51 seconds, the payload stack disintegrated and the booster eventually exploded. Later investigation indicated that maximum dynamic pressure during the ascent trajectory tore a new payload shroud off at its weakest tension points. Despite an intensive effort, searchers were unable to find the polonium-20 radioactive isotope heat source in the rover. Unconfirmed rumors still abound that soldiers at the launch site used the isotope to heat their barracks during the bitter winter of 1968.

105)

no name / [N1 launch test]

Nation: USSR (61)
Objective(s): lunar orbit
Spacecraft: 7K-L1S (no. 2)
Spacecraft Mass: 6,900 kg
Mission Design and Management: TsKBEM
Launch Vehicle: N1 (no. 15003)
Launch Date and Time: 21 February 1969 / 09:18:07 UT
Launch Site: NIIP-5 / launch site 110P
Scientific Instruments: unknown
Results: This was the first attempted launch of the giant N1 booster as part of early test operations in the Soviet piloted lunar landing program. N1 development began in 1962 after two years of initial R&D on heavy booster designs. Although the first launch had been originally planned for 1965, a major redesign of the booster in 1964 and financial and organizational difficulties delayed the launch by four years. On this first launch, the N1 carried a basic 7K-L1 spacecraft (openly known as Zond) modified for operations in lunar orbit (rather than for circumlunar flight). Known as the 7K-L1S, the spacecraft was equipped with an Engine Orientation Complex (DOK) for attitude control in lunar orbit. During the launch, two first-stage engines initially shut down, but the remainder of the engines operated until T+70 seconds when the control system shut them down. The booster crashed about 50 kilometers from the launch site, and the payload successfully used its launch escape system to descend without problem 32 to 35 kilometers from the pad. Investigators believed that booster failed when a pipe for measuring fuel pressure broke at T+23.3 seconds that set in motion a sequence of events that led to a huge fire at T+54.5 seconds in the tail of the first stage. The fire short-circuited the control system and shut down all the engines at approximately T+70 seconds.

106)

Mariner 6

Nation: U.S. (45)
Objective(s): Mars flyby
Spacecraft: Mariner-69F / Mariner-F
Spacecraft Mass: 381 kg
Mission Design and Management: NASA JPL
Launch Vehicle: Atlas-Centaur (AC-20 / Atlas 3C no. 5403C / Centaur D-1A)
Launch Date and Time: 25 February 1969 / 01:29:02 UT
Launch Site: ETR / launch complex 36B
Scientific Instruments:

1) imaging system (two TV cameras)
2) infrared spectrometer
3) ultraviolet spectrometer
4) infrared radiometer
5) celestial mechanics experiment
6) S-band occultation experiment

Results: Mariners 6 and 7, identical spacecraft intended to fly by Mars, were the first Mariner spacecraft launched by the Atlas-Centaur, permitting a heavier instrument suite. Both spacecraft were intended to study the surface and atmosphere of Mars during close flybys. All onboard instrumentation was designed to collect data on Mars; there were no experiments for study of interplanetary space. The 3.35-meter-tall spacecraft was constructed around an eight-sided magne-

sium framework with four rectangular solar panels for 449 watts power. The heart of the spacecraft was the 11.8-kilogram Control Computer and Sequencer (CC&S), which was designed to operate Mariner independently without intervention from ground control. After a midcourse correction on 1 March 1969 and preliminary imaging sessions (fifty photos) on 28 July, Mariner 6 flew by Mars at 05:19:07 UT on 31 July at a distance of 3,429 kilometers. Just 15 minutes prior to closest approach (just south of the Martian equator), the two TV cameras on a scan platform began taking photos of the planet automatically every 42 seconds. During a period of 17 minutes, Mariner 6 took twenty-four near-encounter photos that were stored and later transmitted to Earth. The photos showed heavily cratered and chaotic areas not unlike parts of the Moon. Images of the south polar region showed intriguing detail of an irregular border. The scientific instruments indicated that the polar cap gave off infrared radiation consistent with solid carbon dioxide. Mariner 6 found surface pressure to be equal to about 30.5 kilometers above Earth's surface. Atmospheric composition was about 98 percent carbon dioxide. Surface temperatures ranged from –73°C at night to –125°C at the south polar cap.

107)
no name / [Mars]
Nation: USSR (62)
Objective(s): Mars orbit
Spacecraft: M-69 (no. 521)
Spacecraft Mass: c. 3,800 kg
Mission Design and Management: GSMZ Lavochkin
Launch Vehicle: 8K82K + Blok D (Proton no. 240-01)
Launch Date and Time: 27 March 1969 / 10:40:45 UT
Launch Site: NIIP-5 / launch site 81L
Scientific Instruments:

1) radiometer
2) instrument to measure water vapor levels
3) ultraviolet spectrometer
4) radiation detector
5) gamma spectrometer
6) hydrogen/helium mass spectrometer
7) spectrometer
8) low-energy ion spectrometer
9) imaging system (three cameras)

Results: The M-69 series of Mars spacecraft was the first of a new generation of Mars probes designed by the Lavochkin design bureau for launch on the heavy Proton booster. Although the 1969 missions were originally meant for both Mars orbit and landing, weight constraints late in mission design forced engineers to delete the lander and focus only on a Mars orbit mission. The probes were designed around a single large spherical tank to which three pressurized compartments were attached. After two en route midcourse corrections, the spacecraft were intended to enter orbit around Mars at roughly 1,700 x 34,000 kilometers at 40° inclination. After an initial photography mission, the probes would lower their pericenter to about 500 to 700 kilometers for a second imaging mission. Total mission lifetime would be about three months. During the launch of the first M-69, the Proton's third stage stopped firing at T+438.66 seconds, after its turbopump had caught on fire because of a faulty rotor bearing. The probe, scheduled to reach Mars orbit on 11 September 1969, never even reached Earth orbit.

108)
Mariner 7
Nation: U.S. (46)
Objective(s): Mars flyby
Spacecraft: Mariner-69G
Spacecraft Mass: 381 kg
Mission Design and Management: NASA JPL
Launch Vehicle: Atlas-Centaur (AC-19 / Atlas 3C no. 5105C / Centaur D-1A)
Launch Date and Time: 27 March 1969 / 22:22:01 UT
Launch Site: ETR / launch complex 36A
Scientific Instruments:

1) imaging system (two TV cameras)
2) infrared spectrometer
3) ultraviolet spectrometer
4) infrared radiometer
5) celestial mechanics experiment
6) S-band occultation experiment

Results: Identical to Mariner 6, Mariner 7 had a similar mission of flying by Mars. After Mariner 6 had returned intriguing photos of Mars's south polar cap, controllers reprogrammed Mariner 7's control system to increase the number of scans of the south pole

for the second spacecraft from twenty-five to thirty-three. Following a perfect midcourse correction on the way to Mars on 8 April 1969, on 30 July, just 7 hours before Mariner 6 was scheduled to fly by Mars, the deep space tracking station at Johannesburg, South Africa, lost contact with the spacecraft's high-gain antenna. One of two stations in Madrid, Spain, was diverted from its original mission of tracking Pioneer 8 and joined the search for Mariner 7. Fortunately, the Pioneer station at Goldstone picked up faint signals from the spacecraft. Controllers sent commands to Mariner 7 to switch to the low-gain antenna, which worked well afterwards. Despite problems with positional calibration, Mariner 7 recorded ninety-three far-encounter and thirty-three near-encounter images of the planet, showing heavily cratered terrain very similar to images recorded by Mariner 6. The closest approach to Mars was at 05:00:49 UT on 5 August 1969, at a distance of 3,430 kilometers. Oddly, despite the high resolution of 300 meters, Mariner 7 found the center of Hellas to be devoid of craters. The spacecraft found a pressure of 3.5 millibars and a temperature of –90°F at 59° south latitude and 28° east longitude in the Hellespontus region, suggesting that this area was elevated about 6 kilometers above the average terrain. One photo from Mariner 7 showed the moon Phobos. Although surface features were not visible, the picture clearly showed the moon to be irregularly shaped.

109)
no name / [Mars]
Nation: USSR (63)
Objective(s): Mars orbit
Spacecraft: M-69 (no. 522)
Spacecraft Mass: c. 3,800 kg
Mission Design and Management: GSMZ Lavochkin
Launch Vehicle: 8K82K + Blok D (Proton no. 233-01)
Launch Date and Time: 2 April 1969 / 10:33:00 UT
Launch Site: NIIP-5 / launch site 81P
Scientific Instruments:
1) radiometer
2) instrument to measure water vapor levels
3) ultraviolet spectrometer
4) radiation detector
5) gamma spectrometer
6) hydrogen/helium mass spectrometer
7) spectrometer
8) low-energy ion spectrometer
9) imaging system (three cameras)

Results: The second M-69 spacecraft was identical to its predecessor (launched six days before) and was intended to enter orbit around Mars on 15 September 1969. Like its twin, it never reached intermediate-Earth orbit. At launch, at T+0.02 seconds, one of the six first-stage engines of the Proton exploded. Although the booster lifted off using the remaining five engines, it began veering off course and eventually assumed horizontal attitude, at which point all the remaining first-stage engines shut down. At T+41 seconds, the booster impacted 3 kilometers from the launch site in a massive fireball.

110)
no name / [Luna]
Nation: USSR (64)
Objective(s): lunar sample return
Spacecraft: Ye-8-5 (no. 402)
Spacecraft Mass: c. 5,700 kg
Mission Design and Management: GSMZ Lavochkin
Launch Vehicle: 8K82K + Blok D (Proton no. 238-01)
Launch Date and Time: 14 June 1969 / 04:00:47 UT
Launch Site: NIIP-5 / launch site 81P
Scientific Instruments:
1) stereo imaging system
2) remote arm for sample collection
3) radiation detector

Results: The Ye-8-5 was a variant of the basic Ye-8 lunar rover spacecraft developed by the Lavochkin design bureau. This particular version, whose development began in 1968, was designed to recover a small portion of soil from the lunar surface and return it to Earth. It had the same basic lander stage ("KT") as that of the rover variant (built around a structure comprising four spherical propellant tanks linked together in a square), which was installed with a robot arm to scoop up lunar soil. The rover was replaced by a new "ascent stage" that was built around three spherical propellant tanks that consisted of a main rocket engine to lift off from the Moon, a pres-

surized compartment for electronics, and a small, 39-kilogram spherical capsule that would detach from the stage and reenter Earth's atmosphere with its valuable payload of lunar dust. On the first launch attempt of the Ye-8-5 robot scooper, the first three stages of the Proton worked without fault, but the Blok D fourth stage, which was to fire to attain orbital velocity, failed to ignite due to a disruption in the circuit of its guidance system. The spacecraft reentered Earth's atmosphere over the Pacific without reaching orbit.

111)
no name / [N1 test flight]
Nation: USSR (65)
Objective(s): lunar orbit
Spacecraft: 7K-L1S
Spacecraft Mass: c. 6,900 kg
Mission Design and Management: TsKBEM
Launch Vehicle: N1 (no. 15005)
Launch Date and Time: 3 July 1969 / 20:18:32 UT
Launch Site: NIIP-5 / launch site 110P
Scientific Instruments: unknown
Results: This was the second attempt to launch the giant N1 rocket. As with its predecessor, its payload consisted of a basic 7K-L1 ("Zond") spacecraft equipped with additional instrumentation and an attitude-control block to enable operations in lunar orbit. Moments after launch, the first stage of the booster exploded in a massive inferno that engulfed the entire launch pad and damaged nearby buildings and structures for several kilometers around the area. Amazingly, the payload's launch escape system operated without fault, and the Zond descent apparatus (or descent module) was recovered safely 2 kilometers from the pad. An investigation commission traced the cause of the failure to the entry of a foreign object into the oxidizer pump of one of the first-stage engines at T-0.25 seconds. The ensuing explosion started a fire that began to engulf the first stage. The control system shut down all engines except one by T+10.15 seconds. The booster lifted about 200 meters off the pad and then came crashing down in a massive explosion.

112)
Luna 15
Nation: USSR (66)
Objective(s): lunar sample return
Spacecraft: Ye-8-5 (no. 401)
Spacecraft Mass: 5,700 kg
Mission Design and Management: GSMZ Lavochkin
Launch Vehicle: 8K82K + Blok D (Proton no. 242-01)
Launch Date and Time: 13 July 1969 / 02:54:42 UT
Launch Site: NIIP-5 / launch site 81P
Scientific Instruments:
1) stereo imaging system
2) remote arm for sample collection
3) radiation detector

Results: Luna 15, launched only three days before the historic Apollo 11 mission to the Moon, was the second Soviet attempt to recover and bring lunar soil back to Earth. In a race to reach the Moon and return to Earth, the parallel missions of Luna 15 and Apollo 11 were, in some ways, the culmination of the Moon race that defined the space programs of both the United States and the Soviet Union in the 1960s. After a midcourse correction the day after launch, Luna 15 entered lunar orbit at 10:00 UT on 17 July 1969. The spacecraft remained in lunar orbit for two days while controllers checked all onboard systems and performed two orbital maneuvers. After astronauts Armstrong and Aldrin had already set foot on the Moon, Luna 15 fired its main retrorocket engine to initiate descent to the surface at 15:47 UT on 21 July 1969. Unfortunately, transmissions ceased only 4 minutes after deorbit at a calculated altitude of 3 kilometers. The spacecraft had probably crashed onto the side of a mountain. Impact coordinates were 17° north latitude and 60° east longitude in Mare Crisium.

113)
Zond 7
Nation: USSR (67)
Objective(s): circumlunar flight
Spacecraft: 7K-L1 (no. 11)
Spacecraft Mass: c. 5,375 kg
Mission Design and Management: TsKBEM
Launch Vehicle: 8K82K + Blok D (Proton no. 243-01)
Launch Date and Time: 7 August 1969 / 23:48:06 UT
Launch Site: NIIP-5 / launch site 81L

Scientific Instruments:

1) biological payload
2) radiation detectors
3) imaging system

Results: Following a spate of partial successes and catastrophic failures, Zond 7 was the first fully successful Soviet circumlunar mission. The spacecraft had been the last 7K-L1 vehicle manufactured for robotic flight. In the original schedule, the next flight would have been piloted. Like its predecessors, Zond 7 carried a set of biological specimens, including four male steppe tortoises that were part of a group of thirty selected for an experiment. After a mid-course correction on 8 August, the spacecraft successfully circled the far side of the Moon two days later at a range of 1,200 kilometers. Zond 7 performed color imaging sessions on 8 August (of Earth) and 11 August (two sessions of both Earth and the Moon). The only major malfunction during the mission was the failure to deploy the main parabolic antenna (due to a problem in the securing cables), but this did not prevent fulfillment of all the primary goals of the mission. Zond 7 successfully carried out a guided reentry over Earth's atmosphere and landed without problem south of Kustanay in Kazakhstan after a 6-day 18-hour 25-minute flight.

114)
Pioneer
Nation: U.S. (47)
Objective(s): solar orbit
Spacecraft: Pioneer-E
Spacecraft Mass: 65.4 kg
Mission Design and Management: NASA ARC
Launch Vehicle: Thor-Delta L (no. 73 / Thor no. 540)
Launch Date and Time: 27 August 1969 / 15:59 UT
Launch Site: ETR / launch complex 17A
Scientific Instruments:

1) three-axis magnetometer
2) cosmic-ray telescope
3) radio propagation detector
4) electric field detector
5) quadrispherical plasma analyzer
6) cosmic-ray-anisotropy detector
7) cosmic dust detector
8) celestial mechanics experiment

Results: At T+31 seconds in the launch of this Pioneer probe, the hydraulics system of the first stage of the booster developed a problem that eventually culminated in complete loss of pressure at T+213 seconds, only 4 seconds prior to main-engine cutoff of the first stage. Although second-stage performance was nominal, there was no way to compensate for the large pointing error introduced by the malfunctions in the first stage. With the booster veering off course, ground control sent a command to destroy the vehicle at T+484 seconds. Pioneer-E was the last in a series of probes intended for studying interplanetary space from heliocentric orbit. An additional payload on the Thor-Delta L was a Test and Training Satellite (TETR) to test the Apollo ground tracking network.

115)
Kosmos 300 / [Luna]
Nation: USSR (68)
Objective(s): lunar sample return
Spacecraft: Ye-8-5 (no. 403)
Spacecraft Mass: c. 5,700 kg
Mission Design and Management: GSMZ Lavochkin
Launch Vehicle: 8K82K + Blok D (Proton no. 244-01)
Launch Date and Time: 23 September 1969 / 14:07:36 UT
Launch Site: NIIP-5 / launch site 81P
Scientific Instruments:

1) stereo imaging system
2) remote arm for sample collection
3) radiation detector

Results: This was the third attempt to send a sample return spacecraft to the Moon (after failures in June and July 1969). On this attempt, the spacecraft successfully reached Earth orbit but failed to inject itself on a translunar trajectory. Later investigation indicated that the Blok D upper stage had failed to fire a second time for translunar injection because of a problem with a fuel injection valve that had become stuck during the first firing of the Blok D (for Earth orbital insertion). As a result, all the liquid oxygen in the Blok D was depleted. The Soviet press named the vehicle Kosmos 300 without alluding to its lunar goal. The payload's orbit decayed about four days after launch.

116)
Kosmos 305 / [Luna]
Nation: USSR (69)

Objective(s): lunar sample return
Spacecraft: Ye-8-5 (no. 404)
Spacecraft Mass: c. 5,700 kg
Mission Design and Management: GSMZ Lavochkin
Launch Vehicle: 8K82K + Blok D (Proton no. 241-01)
Launch Date and Time: 22 October 1969 / 14:09:59 UT
Launch Site: NIIP-5 / launch site 81P
Scientific Instruments:

1) stereo imaging system
2) remote arm for sample collection
3) radiation detector

Results: Exactly one lunar month after the failure of Kosmos 300, the Soviets launched another Ye-8-5 lunar sample return spacecraft. Once again, the spacecraft failed to leave Earth orbit. When the Blok D upper stage was meant to fire for translunar injection, telemetry readings went off scale and communications were lost. There had apparently been a programming failure in one of the radio-command blocks designed to command the Blok D to fire. The Soviet press merely referred to the probe as Kosmos 305. The spacecraft's orbit decayed over Australia before the craft completed a single orbit of Earth.