50)
Ranger 8
Nation: U.S. (21)
Objective(s): lunar impact
Spacecraft: Ranger-C
Spacecraft Mass: 366.87 kg
Mission Design and Management: NASA JPL
Launch Vehicle: Atlas-Agena B (no. 13 / Atlas D no. 196 / Agena B no. 6006)
Launch Date and Time: 17 February 1965 / 17:05:00 UT
Launch Site: ETR / launch complex 12
Scientific Instruments: Imaging system (six TV cameras)
Results: As successful as its predecessor, Ranger 8 returned 7,137 high-resolution photographs of the lunar surface prior to its scheduled impact at 09:57:37 UT on 20 February. Unlike Ranger 7, however, Ranger 8 turned on its cameras about 8 minutes earlier to return pictures with resolution comparable to Earth-based telescopes (for calibration and comparison purposes). Controllers attempted to align the cameras along the main velocity vector (to reduce imagine smear) but abandoned this maneuver to allow greater area coverage. There had also been a mysterious loss of telemetry during a midcourse correction on 18 February that gave rise for concern, although the mission was completed successfully. Ranger 8 impacted at 2°43' north latitude and 24°38' east longitude, just 24 kilometers from its intended target point in the equatorial region of the Sea of Tranquillity—an area that Apollo mission planners were particularly interested in studying.

51)
"Atlas-Centaur 5"
Nation: U.S. (22)
Objective(s): highly elliptical orbit
Spacecraft: SD-1
Spacecraft Mass: 951 kg
Mission Design and Management: NASA JPL
Launch Vehicle: Atlas-Centaur (AC-5 / Atlas C no. 156D / Centaur C)
Launch Date and Time: 2 March 1965 / 13:25 UT
Launch Site: ETR / launch complex 36A
Scientific Instruments: none
Results: This mission was designed to rehearse a complete Centaur upper-stage burn in support of the Surveyor lunar lander program. On a nominal mission, the Centaur would boost its payload on a direct-ascent trajectory to the Moon. On this test flight, SD-1, a nonfunctional dynamic model, would be boosted on a simulated lunar transfer trajectory to a hypothetical Moon with an orbit of 167 x 926,625 kilometers. During the actual launch, less than 1 second after liftoff, a faulty valve caused both Atlas main engines to shut down. As a result, the booster fell back onto the pad and exploded.

52)
Kosmos 60 / [Luna]
Nation: USSR (30)
Objective(s): lunar soft-landing
Spacecraft: Ye-6 (no. 9)
Spacecraft Mass: c. 1,470 kg
Mission Design and Management: OKB-1
Launch Vehicle: 8K78 (no. R103-25)
Launch Date and Time: 10 April 1965 / N/A
Launch Site: NIIP-5
Scientific Instruments:
1) imaging system
2) radiation detector
Results: Yet another Soviet attempt to soft-land a Ye-6 probe on the lunar surface ended in failure when the Blok L upper stage failed to fire for the translunar injection burn. Instead, the spacecraft remained stranded in Earth orbit. A later investigation indicated that there had been a short circuit in an inverter within the I-100 guidance system of the spacecraft (which also controlled the Blok L stage) preventing engine ignition. The spacecraft's orbit decayed five days later.

53)
Ranger 9
Nation: U.S. (23)
Objective(s): lunar impact
Spacecraft: Ranger-D
Spacecraft Mass: 366.87 kg
Mission Design and Management: NASA JPL
Launch Vehicle: Atlas-Agena B (no. 14 / Atlas D no. 204 / Agena B no. 6007)
Launch Date and Time: 21 March 1965 / 21:37:02 UT
Launch Site: ETR / launch complex 12
Scientific Instruments:
1) imaging system (six TV cameras)
Results: Ranger 9 was the final Ranger mission of the Block III series and closed out the program as a whole. Since both Ranger 7 and Ranger 8 had provided sufficient photographs of the mare regions (potential landing sites for the early Apollo missions), Ranger 9 was targeted to the more geologically interesting Alphonsus crater in the lunar highlands, at that time a possible site for recent volcanic activity. Following a midcourse correction on 23 March, the spacecraft headed directly to its impact point. Only 20 minutes prior to impact, Ranger 9 began taking the first of 5,814 pictures from an altitude of 2,100 kilometers. Unlike its predecessors, the cameras this time were aimed directly in the direction of travel and provided some spectacular shots as the spacecraft approached the lunar surface. These pictures were converted for live viewing on commercial TV. Best resolution was up to 25 centimeters just prior to impact. The spacecraft crashed into the Moon at 14:08:20 UT on 24 March at 12.83° south latitude and 357.63° east longitude, about 6.5 kilometers from its scheduled target.

54)
no name / [Luna]
Nation: USSR (31)
Objective(s): lunar soft-landing
Spacecraft: Ye-6 (no. 8)
Spacecraft Mass: c. 1,470 kg
Mission Design and Management: OKB-1
Launch Vehicle: 8K78 (no. R103-26)
Launch Date and Time: 10 April 1965 / N/A
Launch Site: NIIP-5 / launch site 1
Scientific Instruments:
1) imaging system
2) radiation detector
Results: This was the seventh consecutive failure to accomplish a lunar soft-landing by the Soviets. On this mission, engineers redesigned the problematic I-100 guidance system that had caused most of the previous failures. Previously, the I-100 unit had controlled both the Blok L upper stage and the spacecraft itself. On this mission (and subsequent Lunas), the fourth stage and the Ye-6 spacecraft had separate systems. Unfortunately, this probe never reached Earth orbit. During the launch, depressurization of a nitrogen pipe for the liquid oxygen tank on the third stage had prevented third-stage engine ignition. The spacecraft broke up over the Pacific without reaching orbit.

55)
Luna 5
Nation: USSR (32)
Objective(s): lunar soft-landing
Spacecraft: Ye-6 (no. 10)
Spacecraft Mass: 1,476 kg
Mission Design and Management: OKB-1
Launch Vehicle: 8K78M (no. U103-30)
Launch Date and Time: 9 May 1965 / 07:49:37 UT
Launch Site: NIIP-5 / launch site 1

Scientific Instruments:

1) imaging system
2) radiation detector

Results: In May 1965, Luna 5 became the first Soviet probe to head for the Moon in two years. Following the midcourse correction on 10 May, the spacecraft began spinning around its main axis due to a problem in a flotation gyroscope in the I-100 guidance system unit. A subsequent attempt to fire the main engine failed because of ground control error, and the engine never fired. After loss of control as a result of the gyroscope problem, Luna 5 crashed. Landing coordinates were 31° south latitude and 8° west longitude. It was the second Soviet spacecraft to land on the Moon (following Luna 2 in 1959).

56)

Luna 6

Nation: USSR (33)
Objective(s): lunar soft-landing
Spacecraft: Ye-6 (no. 7)
Spacecraft Mass: 1,442 kg
Mission Design and Management: OKB-1
Launch Vehicle: 8K78M (no. U103-31)
Launch Date and Time: 8 June 1965 / 07:40 UT
Launch Site: NIIP-5 / launch site 1
Scientific Instruments:

1) imaging system
2) radiation detector

Results: On this ninth Soviet attempt at a lunar soft-landing, the mission proceeded as planned until the major midcourse correction late on 9 June. Although the main retro-rocket engine (the S5.5A) ignited on time, it failed to cut off and continued to fire until propellant supply was exhausted. An investigation later indicated that the problem had been due to human error; a command had been mistakenly sent to the timer that ordered the main engine to shut down. Although the spacecraft was sent on a completely wrong trajectory, ground controllers put the spacecraft through a series of steps to practice an actual landing, all of which were satisfactorily accomplished. Luna 6 passed by the Moon late on 11 June at a range of 161,000 kilometers and eventually entered heliocentric orbit. Contact was maintained to a distance of 600,000 kilometers from Earth.

57)

Zond 3

Nation: USSR (34)
Objective(s): lunar flyby
Spacecraft: 3MV-4 (no. 3)
Spacecraft Mass: 950 kg
Mission Design and Management: OKB-1
Launch Vehicle: 8K78
Launch Date and Time: 18 July 1965 / N/A
Launch Site: NIIP-5 / launch site 1
Scientific Instruments:

1) imaging system
2) ultraviolet spectrograph
3) ultraviolet and infrared spectrophotometer
4) meteoroid detectors
5) radiation sensors (cosmic rays, solar wind)
6) magnetometer
7) ion thrusters
8) radio telescope

Results: This "third-generation" deep space probe had originally been slated for a Mars flyby in late 1964 but could not be prepared on time. Instead, Soviet designers diverted the mission for a simple lunar flyby in 1965 to test its basic systems and photograph the far side of the Moon. After a successful translunar injection burn, Zond 3 approached the Moon after only a 33-hour flight. Its imaging mission began on 20 July at a range of 11,570 kilometers from the near side of the Moon. The camera system used a similar system to that of Luna 3, with onboard exposure, development, fixing, and drying prior to scanning for transmission to Earth. In total, the spacecraft took twenty-five visual and three ultraviolet images during its flyby. The closest approach was to 9,220 kilometers. These pictures were successfully transmitted back to Earth on 29 July, nine days after Zond 3's lunar encounter, when it was 2.2 million kilometers from Earth. Further communications sessions occurred on 23 October (involving photo transmissions) when Zond 3 was 31.5 million kilometers from Earth. The last contact was sometime in early March 1966, when the spacecraft was 153.5 million kilometers away. During the mission, it had photographed the unseen 30 percent of the far side of the Moon. Zond 3 also demonstrated successful course correction using

both solar and stellar orientation, a first for a Soviet spacecraft.

58)
Surveyor Model 1
Nation: U.S. (24)
Objective(s): highly elliptical orbit
Spacecraft: SD-2
Spacecraft Mass: 950 kg
Mission Design and Management: NASA JPL
Launch Vehicle: Atlas-Centaur (AC-6 / Atlas D no. 151D / Centaur D)
Launch Date and Time: 11 August 1965 / 14:31:04 UT
Launch Site: ETR / launch complex 36B
Scientific Instruments: none
Results: This was the second attempt to launch a dummy Surveyor lunar lander spacecraft into a barycentric orbit toward a simulated Moon. Unlike the results of the previous attempt (in March 1965), all systems worked without fault; the Surveyor dynamic model was inserted on a simulated lunar trajectory so precise that it would have landed on the Moon without a trajectory correction on an actual mission. The spacecraft reentered Earth's atmosphere after thirty-one days.

59)
Luna 7
Nation: USSR (35)
Objective(s): lunar soft-landing
Spacecraft: Ye-6 (no. 11)
Spacecraft Mass: 1,506 kg
Mission Design and Management: OKB-1
Launch Vehicle: 8K78 (no. U103-27)
Launch Date and Time: 4 October 1965 / 07:56:40 UT
Launch Site: NIIP-5 / launch site 1
Scientific Instruments:
1) imaging system
2) radiation detector

Results: Unlike its predecessors, Luna 7 successfully carried out its midcourse correction on 5 October on the way to the Moon, in anticipation of a soft-landing two days later. Unfortunately, immediately prior to planned retro-fire during the approach to the lunar surface, the spacecraft suddenly lost attitude control and failed to regain it. Automatic programmed systems then prevented the main engine from firing. As controllers observed helplessly, Luna 7 plummeted to the lunar surface at a very high speed, crashing at 22:08:24 UT on 7 October west of the Kepler crater, relatively near the actual intended target. Impact coordinates were 9° north latitude and 49° west longitude. Later investigation indicated that the optical sensor of the astronavigation system had been set at the wrong angle and had lost sight of Earth during the critical attitude-control maneuver. It was the tenth consecutive failure in the Ye-6 program.

60)
Venera 2
Nation: USSR (36)
Objective(s): Venus flyby
Spacecraft: 3MV-4 (no. 4)
Spacecraft Mass: 963 kg
Mission Design and Management: OKB-1
Launch Vehicle: 8K78M
Launch Date and Time: 12 November 1965 / N/A
Launch Site: NIIP-5 / launch site 31
Scientific Instruments:
1) three-component magnetometer
2) imaging system
3) solar x-radiation detector
4) cosmic-ray gas-discharge counters
5) piezoelectric detectors
6) ion traps
7) photon Geiger counter
8) cosmic radio emission receivers

Results: Although the 3MV-3 and 3MV-4 type spacecraft were originally intended for Mars exploration, the Soviets re-equipped three of the series, left over from the 1964 Mars launch windows, for Venus exploration in 1965. This particular vehicle was scheduled to fly past the sunlit side of Venus at no more than a 40,000-kilometer range and take photographs. During the outbound flight, communications with the spacecraft were poor. Immediately before closest approach in late February 1966, ground control commanded to switch on all the onboard scientific instrumentation. The closest approach to the planet was at 02:52 UT on 27 February 1966 at about a 24,000-kilometer range. After its flyby, when the spacecraft was supposed to relay back the collected information, ground control was unable to regain contact. Controllers finally gave up all attempts at communication on 4 March. Venera 2 eventually entered heliocentric orbit. Later investigation indicated that improper functioning of

40 thermal radiator elements caused a sharp increase in gas temperatures in the spacecraft. As a result, elements of the receiving and decoding units failed, the solar panels overheated, and contact was lost. Ironically, the scientific instruments may have collected valuable data, but none of it was ever transmitted back to Earth.

61)
Venera 3
Nation: USSR (37)
Objective(s): Venus impact
Spacecraft: 3MV-3 (no. 1)
Spacecraft Mass: 958 kg
Mission Design and Management: OKB-1
Launch Vehicle: 8K78M
Launch Date and Time: 16 November 1965 / N/A
Launch Site: NIIP-5 / launch site 31
Scientific Instruments:

Bus:
1) radiation detector
(rest unknown)

Results: This was the second of three 3MV spacecraft the Soviets attempted to launch toward Venus in late 1965. Venera 3 successfully left Earth orbit and released a small 0.9-meter-diameter, 337-kilogram (some sources say 310-kilogram) landing capsule to explore the Venusian atmosphere and transmit data on pressure, temperature, and composition of the Venusian atmosphere back to Earth during the descent by parachute. During the outbound trajectory, ground controllers successfully performed a midcourse correction on 26 December 1965 and completed 93 communications sessions. However, contact was lost on 16 February 1966, shortly before the Venusian encounter, although the spacecraft automatically released its sterilized lander probe, which landed inertly on the Venusian surface at 06:56 UT on 1 March 1966. It was the first time a humanmade object had made physical contact with another planetary body besides the Moon. Later investigation confirmed that Venera 3 suffered many of the same failures as Venera 2, such as overheating of internal components and the solar panels.

62)
Kosmos 96 / [Venera]
Nation: USSR (38)
Objective(s): Venus flyby
Spacecraft: 3MV-4 (no. 6)
Spacecraft Mass: c. 950 kg
Mission Design and Management: OKB-1
Launch Vehicle: 8K78M
Launch Date and Time: 23 November 1965 / N/A
Launch Site: NIIP-5 / launch site 31
Scientific Instruments:

1) three-component magnetometer
2) imaging system
3) solar x-radiation detector
4) cosmic-ray gas-discharge counters
5) piezoelectric detectors
6) ion traps
7) photon Geiger counter
8) cosmic radio emission receivers

Results: This was the third and last spacecraft prepared for a Venus encounter by the Soviets in 1965. All three spacecraft had originally been intended for Mars exploration in 1964 and 1965. However, during coast to orbit, a combustion chamber in the booster's third-stage engine exploded due to a crack in the fuel pipeline. Although the payload reached Earth orbit, the Blok L upper stage was tumbling and was unable to fire for trans-Venus trajectory injection. The probe remained stranded in Earth orbit, and the Soviets named it Kosmos 96 to disguise its true mission. The probe's orbit decayed on 9 December 1965.

63)
Luna 8
Nation: USSR (39)
Objective(s): lunar soft-landing
Spacecraft: Ye-6 (no. 12)
Spacecraft Mass: 1,552 kg
Mission Design and Management: OKB-1
Launch Vehicle: 8K78 (no. U103-28)
Launch Date and Time: 3 December 1965 / 10:46:14 UT
Launch Site: NIIP-5 / launch site 31
Scientific Instruments:

1) imaging system
2) radiation detector

Results: This, the tenth Soviet attempt to achieve a lunar soft-landing, nearly succeeded. After a successful midcourse correction on 4 December, the spacecraft headed toward the Moon without any apparent problems. Just prior to the planned retro-fire burn, a command was sent to inflate cushioning airbags around the ALS lander probe.

Unfortunately, a plastic mounting bracket apparently pierced one of the two bags. The resulting expulsion of air put the spacecraft into a spin of 12 degrees per second. The vehicle momentarily regained attitude, long enough for a 9-second retro-engine firing, but then lost it again. Without a full retro-fire burn to reduce approach velocity sufficient for a survivable landing, Luna 8 plummeted to the lunar surface and crashed at 21:51:30 UT on 6 December just west of the Kepler crater. Impact coordinates were 9°8' north latitude and 63°18' west longitude.

64)

Pioneer 6

Nation: U.S. (25)
Objective(s): heliocentric orbit
Spacecraft: Pioneer-A
Spacecraft Mass: 62.14 kg
Mission Design and Management: NASA ARC
Launch Vehicle: Thor-Delta E (no. 35 / Thor no. 460/DSV-3E)
Launch Date and Time: 16 December 1965 / 07:31:21 UT
Launch Site: ETR / launch complex 17A
Scientific Instruments:

1) single-axis fluxgate magnetometer
2) Faraday-cup plasma probe
3) plasma analyzer
4) cosmic-ray telescope
5) cosmic-ray-anisotropy detector
6) radio wave propagation experiment
7) celestial mechanics experiment

Results: Pioneer 6 was the first of four NASA spacecraft designed to study interplanetary phenomena in space. The spacecraft successfully provided simultaneous scientific measurements at widely dispersed locations in heliocentric orbit. It returned the first data on the tenuous solar atmosphere and later recorded the passage of Comet Kohoutek's tail in 1974. Along with Pioneers 7, 8, and 9, the spacecraft formed a ring of solar weather stations spaced along Earth's orbit. Measurements by the four Pioneers were used to predict solar storms for approximately 1,000 primary users, including the Federal Aviation Administration; commercial airlines; power companies; communication companies; military organizations; and entities involved in surveying, navigation, and electronic prospecting. By December 1990, Pioneer 6 had circled the Sun twenty-nine times (traveling 24.8 billion kilometers) and had been operational for twenty years—a record for a deep space probe. Its original slated lifetime had been only six months. On 15 December 1996, the spacecraft's primary transmitter failed, but during a track on 11 July 1996, ground controllers switched on the backup transmitter. Of the spacecraft's six scientific instruments, two (the plasma analyzer and the cosmic-ray detector) still continue to function. NASA maintains contact with the spacecraft once or twice each year. For example, 1 hour's worth of scientific data was collected on 29 July and 15 December 1995 (although the primary transmitter failed soon after that), and again on 6 October 1997, more than thirty years after launch. The probe's solar arrays continue to deteriorate, although the transmitters can be turned on at perihelion when the solar flux is strong enough to provide sufficient power. On 8 December 2000, to commemorate its thirty-fifth anniversary of operation, ground controllers established successful contact with the spacecraft for about 2 hours.