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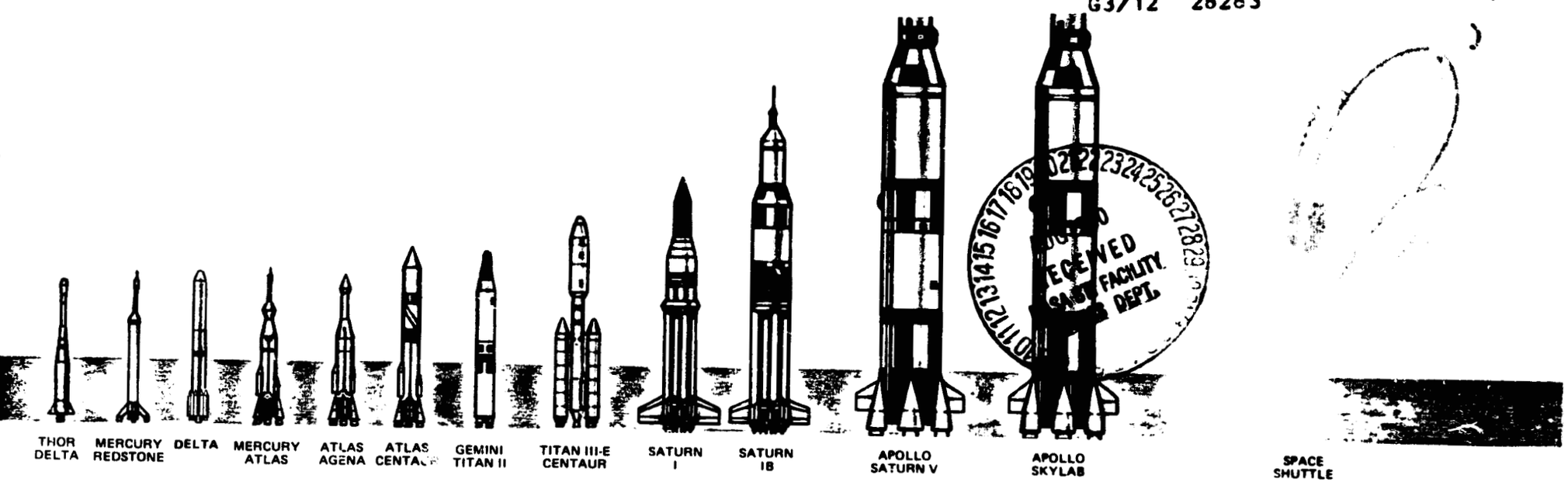
Eastern Test Range (ETR)
Western Test Range (WTR)

A Summary of Major NASA Launches

October 1, 1958 - December 31, 1979



FOREWORD

With the publication of this edition, "A Summary of Major NASA Launches" now spans more than twenty-one years in the launch history of the National Aeronautics and Space Administration, from October 1, 1958, through December 31, 1979. The initial brief summary of NASA Atlantic Missile Range (AMR) launches was prepared in 1962 as a reference tool for internal use within the Launch Operations Center Historical Branch. Repeated requests for information concerning NASA launch activities warranted the presentation of this information in handy form for broader distribution. The Summary now includes major NASA launches conducted under the direction of the John F. Kennedy Space Center (or its precursors) from the Eastern and Western Test Ranges. It does not include launches of non-military, non-NASA spacecraft by the U.S. Air Force or launches of the small NASA Scout vehicle. This edition supersedes all previous issues of this Historical Report.

The material contained in this report was compiled from several different sources. Documents consulted include: Operations Summaries, post-launch Flash Flight Reports, Final Field Reports, Mission Operations Reports (both pre-launch and post-launch), and Satellite Situation Reports. Other major references were publications of the NASA Historical Office, such as: Aeronautics and Astronautics 1916-1960; Aeronautical and Astronautical Events of 1961-1962; Aeronautics and Astronautics (yearly editions since 1963), and NASA's Pocket Statistics (published monthly). The writer is indebted to Mr. Marven R. Whipple, USAF ETR Historian, now retired, for providing data not otherwise available, and to Mr. William A. Lockyer, who prepared the previous edition of this report. Ms. Donna A. Clement, Mr. Joseph L. Green, and Mr. Hubert E. Griggs, McGregor-Werner Information Services Unit, provided valuable editorial assistance.

The report is divided into projects within broad mission categories. Individual launches are listed in chronological order within the categories. Mission results have been categorized as: successful (S); unsuccessful (U); or, partially successful (P). A successful launch, followed by a spacecraft failure, is designated (P). These are arbitrary classifications, made after a comparison of objectives and actual results.

A similar document, prepared in chart form, is available upon request. Comments, criticisms, and suggestions for the improvement of this publication are solicited. Correspondence should be addressed to KSC Historical Services (SI-SRV-1), John F. Kennedy Space Center, NASA, Kennedy Space Center, Florida 32899.

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KSC Historian

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SUMMARY OF MAJOR NASA ETR AND WTR LAUNCHES, 1 OCTOBER 1958--31 DECEMBER 1979

SPACE SCIENCE

PHYSICS AND ASTRONOMY

BEACON

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Beacon	22 Oct 58 2222 EST	Juno I (Jupiter C) (No. 49)	--	ETR 5	Atmospheric physics. Attempt to place a 42-kg (92.6-lb), 3.65-meter (12-feet) diameter inflatable sphere of micro-thin plastic, covered with aluminum foil, into a high-altitude orbit failed; premature upper-stage separation. Payload flight time, 424 seconds. (U)
Beacon	14 Aug 59 1931 EST	Juno II (AM-19B)	--	ETR 26B	Atmospheric physics. Attempt to orbit 3.65-meter (12-feet) diameter, high visibility, aluminum sphere failed due to premature fuel depletion in booster, with ensuing main engine cutoff, and unrelated upper-stage malfunction in attitude control system. (U)

VANGUARD

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Vanguard 2	17 Feb 59 1055 EST	Vanguard SLV-4	1959 Alpha I (satellite) 1959 Alpha II (casing)	ETR 18A	Meteorology. First fully instrumented Vanguard payload in orbit; 9.4 kg (20.74 lb); excessive wobble of sphere was caused by third stage bumping into satellite; cloud cover data not usable. Transmitted for 18 days; still in orbit with an apogee of 3,209 km (1,994 sm) and a perigee of 558 km (347 sm). Period is 125 mins and inclination 32.9°. (P)
Vanguard	13 Apr 59 2149 EST	Vanguard SLV-5	--	ETR 18A	Second-stage failure, tumbling resulted from thrust chamber damage. (U)
Vanguard	22 Jun 59 1616 EDT	Vanguard SLV-6	--	ETR 18A	Second-stage failure; helium tank burst as a result of faulty pressure regulator in propulsion system. (U)
Vanguard 3	18 Sep 59 0020 EST	Vanguard SLV-7	1959 Eta	ETR 18A	Magnetic field, radiation belt, and micrometeoroid findings. This 22.67-kg (50-lb) satellite was last launch in Vanguard program. Transmissions ceased 11 December 1959. Still in orbit--3,607 x 514 km (2,241 x 319 sm), period 129 mins, inclination 33.4°. (S)

EXPLORER

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer	16 Jul 59 1237 EDT	Juno II (AM-16)	S-1	ETR 5	Attempt to place a 41.5-kg (91.5-lb) satellite into orbit. Complete loss of power to guidance and control system at liftoff caused missile to deviate from intended flight path. Destroyed by range safety officer 5-1/2 seconds after launch. (U)
Explorer 6	7 Aug 59 1023 EDT	Thor-Able-3	S-2	ETR 17A	Injected into most eccentric orbit achieved by any satellite up to that time; measured Van Allen belt and cosmic radiation, mapped the Earth's magnetic field, and provided a crude TV image of the Earth's cloud cover. Significant discovery of large electrical current system in the outer atmosphere. Transmitted data until 6 October 1959. Re-entered in July 1961. (S)
Explorer 7	13 Oct 59 1131 EDT	Juno II (AM-19A)	S-1a	ETR 5	41.5-kg (91.5-lb) satellite successfully injected into orbit around the Earth; provided significant data on trapped radiation and cosmic radiation near the Earth. Seventh and last U.S. IGY Earth satellite. Transmitted data until late 1961; still in orbit--1,007 x 545 km (626 x 339 sm), period 100 mins, inclination 50.3°. (S)
Explorer	23 Mar 60 0835 EST	Juno II (AM-19C)	S-46	ETR 26B	Attempt to orbit satellite equipped to analyze radiation energies in the Van Allen radiation zones; orbital velocity not achieved due to failure of upper stages to ignite. Communication with launch vehicle was lost after second-stage burnout. (U)

PHYSICS AND ASTRONOMY
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 8	3 Nov 60 0023 EST	Juno II (AM-19D)	S-30	ETR 26B	All systems functioned normally to put into an elliptical orbit a 40.88-kg (90.14-lb) scientific Earth satellite which confirmed existence of helium layer in upper atmosphere. Transmitted data until 27 December 1960; still in orbit--1,942 x 410 km (1,207 x 25. sm), period 109 mins, inclination 50°. (S)
Explorer	24 Feb 61 0805 EST	Juno II (AM-19F)	S-45	ETR 26B	Primary mission of injecting into orbit an ionosphere satellite was not achieved. Series of irregularities occurred following first stage separation, preventing firing of upper stages. (U)
Explorer 10	25 Mar 61 1017 EST	Delta DM-19 (Delta-4)	S-14	ETR 17A	Satellite probe, 35.83 kg (79 lb), highly eccentric orbit. Transmitted data on Earth and interplanetary magnetic fields and solar wind. Re-entered June 1968. (S)
Explorer 11	27 Apr 61 0927 EST	Juno II (AM-19E)	S-15	ETR 26B	Placed astronomy telescope satellite into orbit to detect high energy gamma rays from cosmic sources and to map their special distribution. All systems on launch vehicle and 37.19-kg (82-lb) spacecraft functioned as planned. Still in orbit--1,668 x 487 km (1,036 x 303 sm), period 107 mins, inclination 28.8°. (S)
Explorer	24 May 61 0348 EDT	Juno II (AM-19G)	S-45a	ETR 26B	Primary mission of injecting artificial Earth satellite into orbit was not achieved. Second stage was not brought to ignition because of apparent voltage drop. Satellite was to study ionosphere measurements. (U)

PHYSICS AND ASTRONOMY
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 12	15 Aug 61 2221 EST	Delta DM-19 (Delta-6)	S-3	ETR 17A	37.64-kg (83-lb) spacecraft designed to provide data on magnetic fields, energetic particles, and solar wind. Data received from all experiments; transmitted until 6 December 1961; re-entered in September 1963. (S)
Explorer 14	2 Oct 62 1711 EST	Delta DSV-3A (Delta-13)	S-3a	ETR 17B	36.28-kg (80-lb) spacecraft injected into highly elliptical orbit--98,476 x 280 km (61,190 x 174 sm), inclination 33°, period 36.4 hours. Energetic particles experiment. Still in orbit, but orbital elements no longer maintained. Data transmission continued until 10 August 1963. (S)
Explorer 15	27 Oct 62 1815 EST	Delta DSV-3A (Delta-14)	S-3b	ETR 17B	A 44.45-kg (98-lb) satellite to study artificial radiation belt. High spin rate, still in orbit, but orbital elements no longer maintained. (S)
Explorer 17	2 Apr 63 2100 EST	Delta DSV-3B (Delta-17)	S-6	ETR 17A	A 183.7-kg (405-lb) satellite studied density, pressure, composition, and temperature of the Earth's upper atmosphere. Re-entered on 24 November 1966. (S)
Explorer 18	26 Nov 63 2130 EST	Delta DSV-3C (Delta-21)	IMP-A (S-74)	ETR 17B	Successful launching of an Interplanetary Monitoring Probe; its mission was to measure the major magnetic field phenomena in space, including the interplanetary magnetic field, interactions of the streaming solar plasma, and the geomagnetic field, galactic and solar radiation. Re-entered in December 1965. (S)

PHYSICS AND ASTRONOMY
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Beacon-Explorer A	19 Mar 64 0614 EST	Delta DSV-3B (Delta-24)	BE-A (S-66)	ETR 17A	Purpose of mission was to study the ionosphere. Contact lost with satellite 22 seconds after third-stage ignition of the Delta booster. Beacon-Explorer was to have reflected back to Earth laser rays fired at it from Wallops Island, Va. The Delta failure was the first in 23 consecutive firings. (U)
Explorer 21	3 Oct 64 2245 EST	Delta DSV-3C (Delta-26)	IMP-B (S-74a)	ETR 17B	Detailed study of environment of cislunar space through cosmic ray, solar wind and magnetic field measurements. The 61.68-kg (136-lb) spacecraft did not achieve an orbit in true interplanetary space as planned, but operated satisfactorily. Re-entered in January 1966. (S)
Explorer 26	21 Dec 64 0400 EST	Delta DSV-3C (Delta-27)	EPE-D (S-3c)	ETR 17A	Particles and fields; study of injection, trapping, and loss mechanisms of trapped radiation belts, both natural and artificial. The 45.8-kg (101-lb) satellite is the fourth in the Energetic Particles Explorer (EPE) series. Still transmitting. Still in orbit, but orbital elements no longer maintained. (S)
Explorer 28	29 May 65 0700 EST	Delta DSV-3C (Delta-31)	IMP-C (S-74b)	ETR 17B	Measured magnetic fields, cosmic rays and solar wind from near-Earth to deep-space distances. Third in the IMP series. Orbit somewhat higher than planned. 58.96-kg (130-lb) satellite re-entered 4 July 1968. (S)

PHYSICS AND ASTRONOMY
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 31	28 Nov 65 2349 EST (2049 PST)	Thor-Agena (Thrust-Augmented) (Thor-Agena-5)	DME-A	WTR SLC-2E	Dual launch of 98.88-kg (218-lb) spacecraft with Alouette 2 (total payload 245 kg--541 lb). Complemented Alouette by taking measurements of ionospheric characteristics with a companion spacecraft as part of ISIS-X program. Still in orbit; still transmitting. Orbital parameters are: 2,939 x 505 km (1,826 x 314 sm), period 121 mins, inclination 79.8°. (S)
Explorer 32	25 May 66 0900 EST	Delta DSV-3C (Delta-38)	AE-B (S-6a)	ETR 17B	Atmosphere Explorer; the 224.5-kg (495-lb) payload was designed to collect temperat composition, density, and pressure data to permit the study of the physics of the atmosphere on a global basis. Still in orbit--1,664 x 255 km (1,034 x 158 sm), period 104 mins, inclination 64.6°. (S)
Explorer 33	1 Jul 66 1102 EST	Delta DSV-3E (Delta-39)	IMP-D	ETR 17A	Anchored Interplanetary Monitoring Platform (AIMP), designed to become the nation's first Moon satellite. However, the second stage of the Delta booster accelerated too rapidly for the retro-rocket compensation necessary to achieve lunar orbit. The 56.7-kg (125-lb) spacecraft went into a looping Earth orbit and sent back information on radiation, magnetic fields, and solar winds. It is still in orbit, but orbital elements are not maintained. (S)
Explorer 34	24 May 67 1006 EDT (0706 PDT)	Delta DSV-3E (Delta-49)	IMP-F	WTR SLC-2E	Interplanetary Monitoring Platform (IMP), satellite to study solar and galactic cosmic radiation, solar plasma, and related phenomena. Highly elliptical polar orbit. All eleven experiments functioned. Re-entered 3 May 1969. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 35	19 Jul 67 1019 EST	Delta DSV-3E (Delta-50)	IMP-E	ETR 17B	Explorer 35 was the 50th Delta launch for NASA, of which only three failed, a 94% success. The 106.5-kg (235-lb) satellite, an Interplanetary Monitoring Platform, studied interplanetary space phenomena with emphasis on study of solar wind and magnetic field at lunar distances. Explorer 35 is in a selenocentric orbit around the Moon. (S)
Explorer 38	4 Jul 68 1326 EDT (1026 PDT)	Delta DSV-3J (Delta-57)	RAE-A	WTR SLC-2E	The 190.5-kg (420-lb) spacecraft, a Radio Astronomy Explorer, was injected into a near-circular orbit. Mission intended to investigate sporadic radio bursts from Jupiter, Earth, and the Sun; radio emission from discrete cosmic sources; plasma oscillations and background radio emission from galactic sources. Still in orbit--5,865 x 5,830 km (3,644 x 3,623 sm), period 224 mins, inclination 120.9°. (S)
Explorer 41	21 Jun 69 0448 EDT (0148 PDT)	Delta DSV-3E (Delta-69)	IMP-G	WTR SLC-2W	The 79-kg (174-lb) spacecraft was launched into a highly elliptical, 129,912 x 343 km (80,723 x 213 sm) orbit with a 3-day, 9-hour, 46-minute period. This was the seventh of 10 missions, beginning with the launch of Explorer 18 (IMP-A) 26 Nov 63. Twelve experiments were aboard the spacecraft to measure cosmic rays, solar plasmas, and magnetic fields in interplanetary space. Solar proton data acquired by this spacecraft supported the Apollo missions. Re-entered atmosphere 23 December 1972. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 43	13 Mar 71 1115 EST	Delta DSV-3M-6 (Delta-83)	IMP-I	ETR 17A	After first launch attempt on 12 Mar was scrubbed due to problem in second stage, Delta-83 successfully launched 288-kg (635-lb) spacecraft into highly elliptical orbit with 206,049-km (128,039-sm) apogee, 241-km (150-sm) perigee, 28.6° inclination and 6,012-min period. Eighth of ten approved IMP spacecraft, Explorer 43 was designed to provide a detailed understanding of regions broadly surveyed by previous seven. First launch from ETR of Delta with six solid motors strapped to first stage and second stage restart capability. Spacecraft re-entered 2 Oct 1974. (S)
Explorer 47	22 Sep 72 2120 EDT	Delta DSV-3N-11A (Delta-90)	IMP-H	ETR 17B	Ninth of currently-approved IMP series, the 376-kg (829-lb) spacecraft was successfully launched on schedule into elliptical transfer orbit. On 25 Sept, satellite kick motor was fired to inject spacecraft into near-circular 235,639 km (146,427 sm) by 201,599 km (124,274 sm) orbit about halfway between Earth and Moon, and changing its inclination (to 17.21°) to provide the optimum science. Period was 12.3 days. More than six months after launch, 12 of 13 scientific instruments aboard satellite were still operational, providing detailed data on the solar-lunar-terrestrial relationship. Still in orbit at 253,505 x 180,416 km (157,520 x 112,105 sm) with a period of 12 days, 3 hrs, 36 mins and inclination of 43.8°. Still transmitting. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 49	10 Jun 73 1013 EDT	Delta DSV-3P-11 (Delta-95)	RAE-B	ETR 17B	After a 24-hour delay due to spacecraft problems, the 330-kg (728-lb) RAE payload was launched on time for its lunar trajectory. Launch trajectory was so accurate that only one of two planned mid-course corrections was required. At 0321 EDT 15 June, the spacecraft's lunar insertion motor was fired to place it in a lunar orbit with an apocynthion of 1,334 km (829 sm) and a pericynthion of 1,123 km (698 sm) at an inclination of 61.3° prograde to the lunar equator. On 18 June the lunar insertion motor was jettisoned and the spacecraft's Velocity Control Propulsion System was fired in the first of a series of maneuvers to circularize the orbit. With its antenna array measuring 458 meters (1,503 feet) tip-to-tip, Explorer 49 was, in physical dimensions, the largest man-made object to circle the Moon. Its instruments studied low-frequency radio emissions from the solar system and other galactic and extragalactic sources. In selenocentric orbit. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 50	25 Oct 73 2226 EDT	Delta DSV-3N (Delta-97)	IMP-J	ETR 17B	This 398-kg (877-lb) satellite was injected into a highly elliptical orbit--286,125 x 155,975 km (177,795 x 96,921 sm); inclination 27.8°; 12-day, 11-hour, 45-min period. Launch was delayed because an operator flipped the wrong switch at T-10 seconds in the countdown. Engine ignition did not occur on time and the count was recycled to T-3 minutes. Second attempt was successful. Interplanetary Monitoring Platform-J (IMP-J) performed detailed studies of energetic and charged particles in the near-Earth interplanetary environment and explored the Earth's magnetosphere. One of the 2 electronic field antennas failed, reducing some of the scientific return of the mission. Still transmitting; in orbit 240,845 x 191,302 km (149,654 x 118,869 sm). (S)
Explorer 51	16 Dec 73 0100 EST (15 Dec 73) (2218 PST)	Delta DSV-3N-1A (Delta-99)	AE-C	WTR SLC-2W	Atmosphere Explorer-C was the first spacecraft in a series of Atmosphere Explorers equipped with unusually powerful on-board propulsion systems, to allow them to make large orbital corrections. AE-C was built to withstand atmospheric friction. It "dipped" into the atmosphere and then out again on each orbit. Its highly elliptical orbit measured 4,199 x 156 km (2,672 x 97 sm), with an inclination of 68.1° and a period of 2 hours, 12 minutes, 30 seconds. Purpose of this orbit was to allow the spacecraft to investigate photo-chemical processes and energy transfer mechanisms accompanying the absorption of solar ultraviolet radiation in the low altitude regions. Re-entered 12 Dec 1978. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 54	6 Oct 75 0500 EDT (0200 PDT)	Delta 2910 (Delta-115)	AE-D	WTR SLC-2W	AE-D was nearly identical to AE-C. Its mission also involved taking atmospheric measurements at altitudes as low as 120 km (75 sm). AE-D's initial orbit was 3,810 x 158 km (2,367 x 97 sm), with an inclination of 90.1° and a period of 2 hours, 7 minutes. The satellite re-entered 12 March 1976. (S)
Explorer 55	19 Nov 75 2107 EST	Delta DSV-3P-11D (Delta-117)	AE-E	ETR 17B	Like its predecessors AE-C and AE-D, this Atmosphere Explorer also circled the Earth, "dipping" through the atmosphere and pulling back out on each orbit. The 737-kg (1,625-lb) spacecraft was injected into an orbit (3,026 x 158 km) (1,880 x 98 sm); inclination 19.7°; and period 1 hour, 50 minutes. Still transmitting; still in orbit--449 x 447 km (279 x 278 sm), period 94 minutes, and inclination 19.6°. (S)

INTERNATIONAL SUN-EARTH EXPLORER (ISEE)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ISEE 1/ ISEE 2	22 Oct 77 0953 EDT	Delta 2914 (Delta-135)	ISEE-A & -B	ETR 17B	ISEE 1 and 2 were the first two International Sun-Earth Explorers in a three spacecraft series. The ISEE satellites were a joint project of NASA and the European Space Agency and contributed to the four-year International Magnetospheric Study (1976-1979). ISEE 1 and 2 were launched simultaneously with ISEE 2 "riding piggyback" atop ISEE 1. Once in orbit, ISEE 2 moved a known distance from ISEE 1, so that scientists could determine changes occurring in the near-Earth space environment. The two ISEEs carried several identical instruments, which returned data on the Earth's magnetosphere, its boundaries, and the movements of radiation trapped within it. However, ISEE 1's solid state telescope projected a reflection, and its data was questionable. Both still in orbit; transmitting on command only. ISEE 1's orbit measures 134,998 x 3,261 km (83,884 x 2,026 sm); ISEE 2's is 134,997 x 3,261 km (83,883 x 2,026 sm). The two spacecraft have identical periods--3,442 minutes--and inclination--51.9°. (S)
ISEE 3	12 Aug 78 1112 EDT	Delta 2914 (Delta-144)	ISEE-C	ETR 17B	ISEE 3 was the third of the three International Sun-Earth Explorers. It was successfully launched and placed at Libration Point 1 (L1), the point in space between the Earth and the Sun where their gravitational forces are exactly counterbalanced. Placed exactly at L1, on the Sun-Earth line, the Sun's radiation would interfere with communications. ISEE was placed in a "halo orbit" around L1 to prevent this. In heliocentric orbit. (S)

INTERNATIONAL ULTRAVIOLET EXPLORER (IUE)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
IUE	26 Jan 78 1236 EST	Delta 2914 (Delta-138)	IUE	ETR 17A	IUE (the International Ultraviolet Explorer) was a cooperative undertaking by NASA, the British Science Council, and the European Space Agency. This orbiting observatory furnished astronomers with spectrograms in the ultraviolet wavelengths, which cannot penetrate the Earth's atmosphere and reach ground-based observatories. IUE discovered a corona of hot gas surrounding our Milky Way galaxy. Before launch the spacecraft weighed 671 kg (1,480 lb); over 227 kg (500 lb) of that weight was the apogee motor and its solid propellant. Orbiting at 45,756 x 25,820 km (28,431 x 16,044 sm), inclination 28.2°, and period 1,436 minutes. Transmitting on command only. (S)

ORBITING SOLAR OBSERVATORY (OSO)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
OSO 1	7 Mar 62 1106 EST	Delta DM-19 (Delta-8)	OSO-A (S-16)	ETR 17A	Measured solar flares and subflares; transmitted data on Sun's radiation in ultraviolet, X-ray, and gamma ray regions, plus other solar phenomena. Prior to 199.58-kg (440-lb) OSO 1, less than an hour of solar phenomena data had been collected from above the Earth's atmosphere. Still in orbit--[illegible]2 x 471 km (306 x 293 sm), inclination 32.9° and period 94 minutes. (S)
OSO 2	3 Feb 65 1136 EST	Delta DSV-3C (Delta-29)	OSO-B-2 (S-17)	ETR 17B	Solar physics; 247.2-kg (545-lb) spacecraft for continuation of OSO 1 studies with added ability to scan the solar disc and part of the corona. Still in orbit--572 x 516 km (355 x 321 sm), inclination 32.9°, and period 96 minutes. (S)
OSO	25 Aug 65 1017 EST	Delta DSV-3C (Delta-33)	OSO-C	ETR 17B	Solar physics; spacecraft was similar to OSO 1 and OSO 2. Failed to orbit due to premature ignition of the third stage. (U)
OSO 3	8 Mar 67 1112 EST	Delta DSV-3C (Delta-46)	OSO-E-1	ETR 17A	Identical to the unsuccessful OSO-C. The 284.4-kg (627-lb) spacecraft carried nine separate experiments to provide data on solar disturbances and radiation in space. In Earth orbit--485 x 471 km (302 x 293 sm), inclination 32.9°, and period 94 minutes. (S)
OSO 4	18 Oct 67 1158 EST	Delta DSV-3C (Delta-53)	OSO-D	ETR 17B	Solar physics. Launched into extremely good circular orbit. All systems on 274.42-kg (605-lb) spacecraft operated normally. Experiments conducted by Harvard College Observatory; American Science and Engineering Inc.; University College, London; Naval Research Laboratory; and Lawrence Radiation Laboratory. Still in orbit--497 x 478 km (309 x 297 sm), inclination 33°, and period 95 minutes.

PHYSICS AND ASTRONOMY
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
OSO 5	22 Jan 69 1148 EST	Delta DSV-3C (Delta-64)	OSO-F	ETR 17B	Launched into an orbit with an apogee of 586.21 and a perigee of 543.59 km (353.07 x 337.77 sm). The 290.75-kg (641-lb) spacecraft contained 120.2 kg (265 lb) of scientific instruments to study solar radiation in the X-ray, gamma ray, and ultraviolet regions of the solar spectrum. The first experiment was turned on during the 11th orbit and the eighth and last was activated during orbit 102 on 29 January. All instruments and spacecraft systems functioned normally. Launch vehicle was last of 30 Delta vehicles of this configuration, all of which performed successfully. Still orbiting at 515 x 496 km (320 x 308 sm), inclination 33°, and period 95 minutes. (S)
OSO 6	9 Aug 69 0352 EDT	Delta DSV-3N (Delta-72)	OSO-G	ETR 17A	The 293.47-kg (647-lb) spacecraft was successfully injected into a 488 x 444 km (303 x 276 sm) orbit, at an inclination of 33°. OSO-G was first in the OSO series to contain an offset pointing and offset rastering capability, enabling investigators to make detailed studies of ultraviolet and X-ray spectra at any point on the solar disk and within a few arc minutes above the limb. The two-stage launch vehicle also carried a Package Attitude Control (PAC) spacecraft, rigidly attached to the second stage, into a 563.6 x 498.9 km (344 x 310 sm) orbit. PAC experiment flight tested a long-life, low-power, 3-axis, Earth-stabilized control system designed to convert the Delta second stage into a stabilized platform for a wide variety of piggy-back payloads. Still in orbit--448 x 417 km (278 x 259 sm), inclination 33°, and period 93 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
OSO 7	29 Sep 71 0545 EDT	Delta DSV-3L (Delta-85)	OSO-H	ETR 17A	Launch vehicle also carried MSFN training satellite TETR-D as a secondary payload. Countdown and liftoff were normal, but a launch vehicle anomaly during coast phase between first and second burns of second stage affected second burn performance, causing the 637-kg (1,404-lb) observatory to be injected into an elliptical, rather than the planned circular orbit, and at a pitch angle outside normal Sun acquisition limits. Ground controllers were able to stabilize the spacecraft and adjust its pitch angle to permit it to lock-on to the Sun. By 29 Nov OSO 7 completed over 850 orbits of the Earth, returning high resolution data from the solar corona in the extreme ultraviolet and visible regions, and the mission was deemed successful. OSO 7 re-entered 9 July 1974. TETR-D re-entered 21 September 1978. (S)
OSO 8	21 Jun 75 0743 EDT	Delta DSV-3P-11D (Delta-112)	OSO-I	ETR 17B	This 1,052-kg (2,319-lb) spacecraft was the eighth and last spacecraft in the OSO series. Like its predecessors, it studied solar radiation that does not penetrate to the Earth's surface and provided long-term observation of the Sun. OSO 8 was an improved and enlarged version of the older ones. It carried eight experiments in a circular low-Earth orbit. Orbital parameters are 530 x 519 km (329 x 322 sm), inclination 33°, and period 95 minutes. (S)

ORBITING GEOPHYSICAL OBSERVATORY (OGO)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
OGO 1	4 Sep 64 2023 EST	Atlas-Agena SLV-3 (Atlas-Agena-10)	OGO-A	ETR 12	First Orbiting Geophysical Observatory, designed to conduct numerous space experiments simultaneously. The 486.7-kg (1,073-lb) OGO-A carried 20 tests. Failure to lock into place resulted in solar panels generating insufficient power to complete all experiments. Considered successful since 75% of planned data acquisition was obtained. Still in orbit; orbital elements not maintained. (S)
OGO 2	14 Oct 65 0911 EST (0611 PST)	Thor-Agena (Thrust-Augmented) (Thor-Agena-4)	OGO-C	WTR SLC-2E	Launched into a low-altitude, nearly polar orbit to allow observation of near-Earth phenomena. 521.63-kg (1,150-lb) spacecraft planned for atmospheric and Earth magnetic survey; 19 of 20 experiments worked but horizon scanners drifted, causing depletion of stabilization gas supply, which caused loss of electrical power. Ceased transmitting on 24 October 1965. Still in orbit --916 x 380 km (569 x 236 sm), inclination 87.3°, and period 98 minutes. (P)
OGO 3	6 Jun 66 2148 EST	Atlas-Agena SLV-3 (Atlas-Agena-16)	OGO-B	ETR 12	Interdisciplinary studies. Earth-Sun space interrelationships using a highly elliptical orbit to correlate studies of particles and fields, atmospheric physics, solar, and other emissions. Development and operation of a standardized, observatory type oriented spacecraft. Demonstrated capability of a three-axis stabilized observatory. 514.82-kg (1,135-lb) spacecraft still in orbit--105,798 x 16,529 km (65,740 x 10,271 sm), inclination 76.3°, and period 2,911 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
OGO 4	28 Jul 67 0921 EST (0621 PDT)	Thor-Agena (Thrust-Augmented) (Thor-Agena-8)	OGO-D	WTR SLC-2E	562.45-kg (1,240-lb) satellite put into nearly polar orbit. Mission to study the effects of solar activity on the Earth's environment during a period of increased solar activity. Re-entered atmosphere 16 August 1972. (S)
OGO 5	4 Mar 68 0806 EST	Atlas-Agena SLV-3A (Atlas-Agena-26)	OGO-E	ETR 13	Fifth of six approved missions in the OGO program. Successfully launched into a parking orbit. After a 32-minute coast period, Agena stage was re-started, injecting the 610.98-kg (1,347-lb) spacecraft into a highly elliptical equatorial orbit. This orbit permits the spacecraft to pass in and out of Earth's magnetosphere, sweeping the forward leading quadrant and the geomagnetic tail, as it acquires data on magnetic fields, energetic particles, and plasma. Last NASA launch from Launch Complex 13, Cape Canaveral. Still in orbit--120,027 x 27,008 km (74,581 x 16,782 sm), inclination 54°, period 3,746 minutes. (S)
OGO 6	5 Jun 69 1042 EDT (0742 PDT)	Thor-Agena (Thrust-Augmented) (Thor-Agena-11)	OGO-F	WTR SLC-2E	The 632.3-kg (1,394-lb) OGO 6 spacecraft, last in the currently programmed OGO series, carried 25 experiments for detailed studies during solar maximum activity in the near-Earth environment. All spacecraft subsystems functioned and experiment performance was satisfactory. OGO spacecraft have carried 130 experiments into orbit and results obtained from over 1.2 million hours of experiment operation to date have been disseminated in more than 300 reports and papers. Still in orbit--448 x 417 km (278 x 259 sm), inclination 33°, and period 93 minutes. (S)

ORBITING ASTRONOMICAL OBSERVATORY (OAO)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
OAO 1	8 Apr 66 1435 EST	Atlas-Agena SLV-3 (Atlas-Agena-15)	OAO-A1	ETR 12	Orbiting Astronomical Observatory. Capable of accurate, long-duration pointing for ultraviolet, X-ray, and gamma ray observations and mapping anywhere in the celestial sphere. 1,769-kg (3,900-lb) spacecraft stopped operating after two days due to battery failure ending communications. However, it is still in orbit. (U)
OAO 2	7 Dec 68 0340 EST	Atlas/ Centaur (AC-16)	OAO-A2	ETR 36B	The launch vehicle successfully injected the 1,995.8-kg (4,400-lb) spacecraft into a near-circular orbit. A total of 11 telescopes were carried on the spacecraft, divided among two experiment packages provided by the University of Wisconsin and the Smithsonian Astrophysical Observatory. The objective was to make precision observations from above the Earth's atmosphere in the relatively unexplored ultraviolet region of the spectrum. Both experiment packages performed successfully. Still in orbit--775 x 765 km (482 x 475 sm), inclination 35°, 100-minute period. (S)
OAO	30 Nov 70 1740 EST	Atlas/ Centaur (AC-21)	OAO-B	ETR 36B	Countdown and liftoff were normal, with a minor 10-minute hold to check spacecraft GSE. However, although the Atlas and Centaur propulsion systems functioned properly, the launch vehicle failed to achieve sufficient velocity to inject the 2,132-kg (4,700-lb) spacecraft into orbit. Telemetry indicated that, although the sequence was initiated on time, the spacecraft shroud panels failed to separate properly. (U)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
OAO 3 (Copernicus)	21 Aug 72 0628 EDT	Atlas/ Centaur (AC-22)	OAO-C	ETR 36B	Terminal countdown proceeded to liftoff with no unscheduled holds. Launch vehicle injected the 2,200-kg (4,900-lb) observatory into a near-perfect circular orbit: 745 x 740 km (463 x 460 sm); 35° inclination; 100-minute period. Following spacecraft checkout, experiment operation began on 29 Aug. By 12 Jan 1973 Copernicus had completed over 2,000 orbits of the Earth with all systems operating satisfactorily, and both primary and secondary mission objectives had been accomplished. Observatory operation was continued. Current orbital parameters are: 742 x 731 km (461 x 454 sm), inclination 35°, and period 100 minutes. (S)

HIGH ENERGY ASTRONOMY OBSERVATORY (HEAO)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
HEAO 1	12 Aug 77 0239 EDT	Atlas Centaur (AC-45)	HEAO-A	ETR 36B	This was the first of three spacecraft launched to detect high energy radiation--X-rays, gamma rays, and cosmic rays. HEAO 1 mapped X-ray sources in the skies; it found more than 1,200. HEAO 1 also located a new black hole candidate. The spacecraft weighed 2,566 kg (5,665 lb) and completed a 17-month mission. Orbit decayed 15 March 1979. (S)
HEAO 2 (Einstein)	13 Nov 78 0024 EST	Atlas/ Centaur (AC-52)	HEAO-B	ETR 36B	HEAO 2, nicknamed "Einstein," was designed to focus on precise points of high energy radiation, rather than to scan the sky as did its predecessor, HEAO 1. HEAO 2 weighed 3,145 kg (6,936 lb) before launch and carried the largest X-ray telescope ever built. The telescope achieved the first photograph of an X-ray burster. Still in orbit--514 x 496 km (319 x 308 sm), inclination 23.5°, period 95 minutes. (S)
HEAO 3	20 Sep 79 0128 EDT	Atlas/ Centaur (AC-53)	HEAO-C	ETR 36B	Third in the series of three orbiting observatories, HEAO 3 was launched into the planned orbit: 507.4 x 494.8 km (315.3 x 307.5 sm), inclination 43.6°, period 94 minutes. The spacecraft had a weight at liftoff of 2,915 kg (6,412 lb). HEAO 3 performed an all-sky survey of cosmic rays and gamma rays, in a manner similar to the X-ray survey performed by HEAO 1, except HEAO 3 operated at a higher orbital inclination. The higher inclination of HEAO 3 took advantage of the greater cosmic ray flux near the Earth's magnetic poles. Still in orbit: 492 x 477 km (306 x 296 sm), 43.6° inclination, 94-minute period. (S)

SPACECRAFT CHARGING AT HIGH ALTITUDES (SCATHA)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
SCATHA	30 Jan 79 1642 EST	Delta 2914 (Delta-148)	SCATHA	ETR 17B	SCATHA (Spacecraft Charging at High Altitudes) was the first spacecraft devoted primarily to studying the tendency of the near-Earth environment to create a build-up of static charges on satellites at geosynchronous orbit altitudes. This accumulation can cause electrical arcing and can damage the spacecraft or some of its components. SCATHA's apogee motor fired on 2 Feb and put the spacecraft into its planned near-geosynchronous drift orbit. SCATHA was a joint project of NASA and the U. S. Air Force; it was operated in orbit by the Air Force. Still orbiting in a path 43,549 x 27,245 km (27,060 x 16,929 sm), with a 7.6° inclination and a 1,416-minute period. (S)

ARIEL

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Ariel 1	26 Apr 62 1300 EST	Delta DM-19 (Delta-9)	S-51 (UK-1)	ETR 17A	First international satellite, joint U. S.-U. K. venture. The 59.87-kg (132-lb) spacecraft performed ionospheric and solar radiation studies. Transmitted until November 1964; decayed 24 May 1976. (S)

ALOUETTE

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Alouette 1	30 Sep 62 0200 EST (29 Sep 62) (2300 PST)	Thor-Agena Thor-Agena B (Thor- (Agena-1)	S-27	WTR SLC-2E	First NASA launch from WTR, first use by NASA of the Thor-Agena. Canadian-built 145-kg (320-lb) satellite, put into polar orbit. Investigated upper levels of ionosphere and aspects of space noise, and measured electron density. Experiments revealed that effective radio frequency reflecting surfaces in the polar regions were very rough, and that temperatures 480 km (300 sm) above the Earth varied greatly and increased with latitude. Still in orbit--1,028 x 992 km (639 x 616 sm), inclination 80.5°, period 105 minutes. (S)
Alouette 2	28 Nov 65 2349 EST (2049 PST)	Thor- Agena-5	Alouette B DME-A	WTR SLC-2E	Dual launch with Explorer 31. Initiated a NASA-Canadian program called International Satellites for Ionospheric Studies (ISIS). Satellites were placed in near-duplicate orbits. Eight experiments of Explorer 31 were correlated with five of 146-kg (323-lb) Alouette 2. Extended to polar regions ionospheric soundings begun by Alouette 1. Still in orbit--2,889 x 504 km (1,795 x 313 sm), inclination 79.8°, period 120 minutes. (S)

INTERNATIONAL SATELLITE FOR IONOSPHERIC STUDIES (ISIS)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ISIS 1	29 Jan 69 0146 EST 28 Jan 69) (2246 PST)	Delta DSV-3E (Delta-65)	ISIS-A	WTR SLC-2E	Launched into a near-polar orbit with an apogee of 3,523 and a perigee of 573 km (2,189 x 356 sm). The International Satellite for Ionospheric Studies (ISIS) was the third of a series of five missions in a U. S./Canadian program to develop a more complete understanding of the upper atmosphere. Following spacecraft checkout, the eight-sided, 235.86-kg (520-lb), Canadian-built satellite was placed in the operational mode on 4 February. Nine of the ten joint experiments on board were operational. Still in orbit--775 x 765 km (482 x 475 sm), inclination 35°, period 100 minutes. (S)
ISIS 2	31 Mar 71 2157 EST (1857 PST)	Delta DSV-3E (Delta-84)	ISIS-B	WTR SLC-2E	264-kg (582-lb) spacecraft, containing 12 experiments provided by Canadian and U. S. investigators, was launched into near-circular orbit: 1,423 x 1,355 km (884 x 842 sm); 88° inclination; 114-minute period. Fourth mission in cooperative U. S./Canadian program designed to develop a better understanding of the physics of the ionosphere. Liftoff occurred 26 minutes into the one-hour launch window due to numerous operational problems encountered during the countdown. All spacecraft systems functioned normally. Still in orbit--1,426 x 1,360 km (886 x 846 sm), inclination 88.1°, period 114 minutes. (S)

EUROPEAN SPACE AGENCY (ESA)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
HEOS 1	5 Dec 68 1355 EST	Delta DSV-3E (Delta-61)	HEOS-A	ETR 17B	NASA launch; non-NASA mission. HEOS (Highly Eccentric Orbit Satellite), the first satellite produced by the European Space Technology Center for the European Space Research Organization (ESRO), carried eight experiments to obtain information on magnetic fields, cosmic radiation, and solar winds from an area beyond the magnetosphere and the shock wave of the Earth. The 107.5-kg (237-lb), 16-sided spacecraft was successfully injected into an elliptical orbit: 222,264 x 422 km (138,108 x 262 sm); inclination 28°; 4-day, 15-hour, 40-minute period. Following verification of orbit, spacecraft control was turned over to the ESRO Operations Center. Re-entered 28 Oct 1975. (S)
HEOS 2	31 Jan 72 1220 EST (0920 PST)	Delta DSV-3L (Delta-87)	HEOS-A2	WTR SLC-2E	HEOS 2 was the second Highly Eccentric Orbit Satellite launched by NASA for the European Space Agency. Its mission was to investigate the high-latitude magnetosphere and search for neutral points at the boundary of the magnetosphere. During prelaunch preparations, the second stage was shipped back to its manufacturer for a modification, and the third stage motor to its manufacturer for an X-ray. HEOS 2 was successfully placed into the planned orbit. Initial orbital parameters were: 240,160 x 406 km (149,233 x 252 sm), inclination 89.9°, and period 5 days, 4 hours, 34 minutes. Re-entered 2 Aug 1974. (S)

INTERNATIONAL SPACE SCIENCE
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
TD 1	11 Mar 72 2055 EST (1755 PST)	Delta DSV-3N (Delta-88)	TD-1/A	WTR SLC-2E	Launch vehicle was two-stage Delta with three strap-on solid-propellant motors on first stage; second stage had restart capability. Total thrust at liftoff (including solids) was 1,460,000 newtons (328,500 lb). First launch attempt on 9 Mar was scrubbed due to problems in second stage velocity control system. Second terminal countdown proceeded normally to liftoff. 472-kg (1,038-lb) spacecraft was successfully injected into near-circular orbit of 542 x 523 km (337 x 325 sm); 98° inclination; 95-minute period. Largest and most advanced European spacecraft, TD 1 was built by consortium of five firms headed by Matra of France; carried seven experiments provided by six European universities and scientific organizations. Launched by NASA for ESRO on a reimbursable basis. Still in orbit--265 x 257 km (165 x 160 sm), 97.4° inclination, 90-minute period. (S)
Cosmic 1	8 Aug 75 2148 EDT (1848 PDT)	Delta DSV-3P-1A (Delta-113)	COS-B	WTR SLC-2W	Developed and owned by the European Space Agency, COS-B studies gamma radiation in the 25 MV to one GV range. Launch was delayed two days by failure of a hydraulic valve in an ARIA aircraft assigned to provide telemetry coverage. COS-B was successfully launched into orbit at 99,834 x 343 km (62,067 x 213 sm) with a 90.1° inclination. The spacecraft weighed 278 kg (612 lb). Still in orbit--89,407 x 9,985 km (55,555 x 6,115 sm), inclination 96.5°, 2,203-minute period. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Geos	20 Apr 77 0515 EST	Delta 2914 (Delta-130)	ESRO/Geos	ETR 17B	Geos was designed to study the propagation path of high-energy particles from the Sun and to give an estimate of the number bombarding the atmosphere. Geos was the first geosynchronous scientific satellite owned and developed by the European Space Agency; it was also the first purely scientific spacecraft scheduled for geosynchronous orbit. However, Geos never reached proper orbit. Its spin table failed to spin up the 3rd stage/ spacecraft combination; consequently, the 3rd stage fired in an improper orientation without effective spin stabilization. The satellite's apogee kick motor was successfully fired 27 Apr 77 to put Geos in the most desirable orbit that was achievable--70,365 x 1,215 km (43,723 x 755 sm), with an inclination of 26°. Geos operated properly but could only fulfill a portion of its scientific objectives. (P)
Geos 2	14 Jul 78 0643 EDT	Delta 2914 (Delta-143)	Geos-2	ETR 17A	Geos 2 was the replacement for the original Geos, which did not achieve the proper orbit. Built as a qualification model, it was identical to Geos 1 and was upgraded to flight status. Geos 2 weighed 574 kg (1,265 lb) prior to launch and 268 kg (591 lb) after burning its apogee motor propellant. It went into the correct orbit, and is now at 35,793 x 35,775 km (22,241 x 22,230 sm), inclination 0.2°, period 1,432 minutes. (S)

HELIOS

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Helios 1	10 Dec 74 0211 EST	Titan/ Centaur (Titan III-Centaur 2)	Helios-A	ETR 41	This was the first of two launches in a joint project of the United States and West Germany, in which the United States supplied two launch vehicles and West Germany two spacecraft. Helios was initially controlled after liftoff by the United States, then turned over to a West German team in Oberpfaffenhofen, West Germany. Helios 1 approached to within 47 million km (29 million sm) of the solar surface and penetrated the outer fringes of the solar corona. The spacecraft reached perihelion on 5 March 1975, where it experienced approximately 11 times more heat than that at the Earth's orbit. Its heat dissipation system worked well, and the spacecraft survived to return a wealth of new data on the Sun, the solar wind, the outer solar corona, and the Sun's magnetic and electric fields. In heliocentric orbit. (S)
Helios 2	15 Jan 76 0034 EST	Titan/ Centaur (Titan III-Centaur 5)	Helios-B	ETR 41	Launched into a heliocentric orbit toward the Sun, the spacecraft achieved man's closest approach to the Sun on 2 April 1976. A cooperative project by the United States and West Germany, the spacecraft provided data on solar plasma, solar wind, cosmic rays and cosmic dust, and performed magnetic and electrical field experiments. In heliocentric orbit. (S)

BIOFLIGHTS (SUBORBITAL PRIMATE FLIGHTS)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Bioflight 1 Living Cargo Monkey Gordo	13 Dec 58 0349 EST	Jupiter (AM-13)	--	ETR 26B	Army-launched missile with capsule containing squirrel monkey Gordo. The vehicle climbed to an altitude of 482 km (300 sm) and traveled 2,414 km (1,500 sm) downrange. Gordo's physiological reactions were monitored and telemetered to ground. He survived 8.3 minutes of weightlessness, 10-g liftoff pressure, and 40-g re-entry pressure without untoward effects. A leak developed in the float mechanism after landing, and the spacecraft and monkey sank and could not be recovered. Not a NASA mission, but data was utilized in Project Mercury planning. (P)
Bioflight 2 Living Cargo Monkeys Able and Baker	28 May 59 0335 EDT	Jupiter (AM-18)	--	ETR 26B	Two monkeys, a 3.17-kg (7-lb) rhesus and .45-kg (1-lb) squirrel monkey, were launched to an altitude of 483 km (300 sm) in a 15-minute flight conducted by the U.S. Army. Electrodes planted beneath the animals' skins reported flight effects upon heart action, temperature, respiration, and muscular reactions. Able's electrocardiograph channel did not record. The environmentally controlled capsule also contained seeds, fruitfly pupae, sea urchin sperm, and human whole blood. The effect of cosmic rays, acceleration, and weightlessness on these items were measured and recorded. The capsule was recovered with the animals unharmed. Not a NASA mission, but data was utilized in Project Mercury planning. (S)

BIOSATELLITE (BIOLOGICAL SATELLITES)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Biosatellite 1	14 Dec 66 1420 EST	Delta DSV-3G (Delta-43)	BIOS-A	ETR 17A	Objective of satellite was to test the effect of weightlessness and space radiation on growth of plants and animals. The 425-kg (937-lb) spacecraft contained millions of animal and plant cells. The retrorocket failed to fire when triggered on the 48th orbit, and no useful data was acquired. Satellite and capsule re-entered 15 February 1967, landing near Australia. A search was performed but they could not be located. (P)
Biosatellite 2	7 Sep 67 1804 EDT	Delta DSV-3G (Delta-51)	BIOS-B	ETR 17B	Objectives were similar to those of BIOS-A. The 433-lb (955-lb) satellite worked well, except for a slight difficulty in accepting ground commands. Because of concern with the command reception and weather in the recovery area, it was decided to de-orbit on orbit 30, rather than continue the 3-day mission. All de-orbit events occurred normally, and capsule was recovered by aircraft over the Pacific within 24 km (15 sm) of predicted impact point on 9 September 1967. Remainder of satellite re-entered atmosphere on 4 October 1967. (S)

BIOSCIENCE
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Biosatellite 3	28 Jun 69 2316 EDT	Delta DSV-3N (Delta-70)	BIOS-D	ETR 17A	Third spacecraft designed for biological experimentation in space and subsequent recovery of specimens. The 677-kg (1,493-lb), 2.4-meter (8-foot) long spacecraft consisted of a re-entry section containing an instrumented 6.8-kg (15-lb) pigtail monkey and an adapter section containing most spacecraft systems. The spacecraft was launched into a 394 x 360 km (245 x 224 sm) orbit with an inclination of about 34°. Although planned for 30 days, the mission was terminated on 7 July when the primate developed an irregular heartbeat and lowered metabolic state. The capsule was recovered but the primate died 12 hours afterward. Remainder of the spacecraft re-entered 20 January 1970. (P)

PIONEER (LUNAR)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Pioneer 1	11 Oct 58 0342 EST	Thor-Able-1	--	ETR 17A	Lunar probe. Uneven separation of second and third stages; reached altitude of 113,808 km (70,717 sm). Verified Van Allen Belt and returned other useful data before payload re-entered after 43 hours. (U)
Pioneer 2	8 Nov 58 0230 EST	Thor-Able-2	--	ETR 17A	Lunar probe. Third stage failed to ignite; reached 1,550 km (963 sm). Brief data indicated that Earth's equatorial region has higher flux and energy levels than previously believed. Suggested micrometeoroid density higher near Earth than in space. (U)
Pioneer 3	6 Dec 58 0045 EST	Juno II (AM-11)	--	ETR 5	Lunar probe. Premature cutoff of first stage, failed to produce required velocity for lunar probe. Reached altitude of 102,322 km (63,580 sm) to contribute major scientific discovery of dual bands of radiation around the Earth. Re-entered after 38 hours, 6 minutes. (U)
Pioneer 4	3 Mar 59 0011 EST	Juno II (AM-14)	--	ETR 5	Lunar probe. Instrumented for space radiation measurements on Earth-Moon trajectory; carried photoelectric scanner for use in vicinity of Moon. Trajectory caused it to pass within 59,545 km (37,000 sm) of Moon; not close enough for scanner to function. Yielded excellent data on radiation in space. Was tracked for 82 hours to a distance of 655,000 km (407,000 sm) (greatest tracking distance for human-made object to date) before going into permanent heliocentric (solar) orbit. (S)

LUNAR AND PLANETARY
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Pioneer	26 Nov 59 0226 EST	Atlas-Able-1	--	ETR 14	Lunar probe. Payload shroud broke away 45 seconds after liftoff; satellite torn off. (U)
Pioneer	25 Sep 60 1013 EST	Atlas-Able-2	P-30	ETR 12	Lunar orbit attempt; failed to achieve trajectory due to second stage malfunction. (U)
Pioneer	15 Dec 60 0410 EST	Atlas-Able-3	P-31	ETR 12	Lunar orbit attempt; exploded 70 seconds after liftoff due to first stage malfunction. (U)

PIONEER (INTERPLANETARY)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Pioneer 5	11 Mar 60 0800 EST	Thor-Able-4	P-2	ETR 17A	Highly successful exploration of interplanetary space between orbits of Earth and Venus; produced first data on nature of interplanetary space; established communication record of 36.2 million km (22.5 million sm) on 26 June 1960, a record unmatched until Mariner 2. First radio communication at interplanetary distances. In solar orbit. (S)
Pioneer 6	16 Dec 65 0231 EST	Delta DSV-3E (Delta-35)	Pioneer-A	ETR 17A	Study of interplanetary phenomena in space. Provided simultaneous scientific measurements at widely separated points in heliocentric orbit in interplanetary space to provide data on interplanetary environment for U.S. advanced space program. In heliocentric orbit. (S)
Pioneer 7	17 Aug 66 1020 EST	Delta DSV-3E (Delta-40)	Pioneer-B	ETR 17A	Heliocentric orbit, measuring solar magnetic field, solar wind, and cosmic rays. Like Pioneer 6, continued measurements of solar activity at widely separated points in interplanetary space. Orbit of 403 days. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Pioneer 8	13 Dec 67 0908 EST	Delta DSV-3E (Delta-55)	Pioneer-C	ETR 17B	Third mission in current Pioneer Program of scientific interplanetary exploration on a continuing basis. Spacecraft was similar in appearance to Pioneers 6 and 7 but contained different experiments. Launch vehicle also carried TTS-1 as a piggyback payload. Intended to collect data including magnetic field, plasma, and cosmic ray measurements in a heliocentric (Sun-centered) orbit for a period covering two or more passages of solar activity centers. Also aided in providing a synoptic study of solar-interplanetary relations by (a) long-term observations using the Pioneer series, and (b) correlative measurements between these spacecraft. Was launched in a path ahead of Earth to give spacecraft added velocity in solar orbit to move out beyond the orbit of Earth. All experiments working properly following orbital injection. Reached Earth's magnetospheric boundary at approximately 1400 EST, 15 December 1967. On 18 January 1968 Sun, Earth and spacecraft were aligned, with spacecraft about 3.2 million km (two million sm) from Earth, thus providing opportunity for further investigation of Earth's magnetic tail (first performed by Pioneer 7 in September 1966). In heliocentric orbit. (S)

LUNAR AND PLANETARY
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Pioneer 9	8 Nov 68 0446 EST	Delta DSV-3E (Delta-60)	Pioneer-D	ETR 17B	Pioneer 9 was injected into a solar orbit with an aphelion of 148,207,998 km (92,091,837 sm) and a perihelion of 112,752,970 km (70,061,186 sm), and a 297.5-day period. The 66.7-kg (147-lb), cylindrical, spin-stabilized spacecraft carried seven scientific experiments, provided by universities, industry and NASA, to obtain data on the properties of the solar wind, cosmic rays, and interplanetary magnetic fields. The launch vehicle also carried a 20-kg (44-lb) secondary payload, a MSFN Test and Training Satellite (TETR-B), which was injected into Earth orbit. In heliocentric orbit. (S)
Pioneer	27 Aug 69 1759 EDT	Delta DSV-3L (Delta-73)	Pioneer-E	ETR 17A	A problem developed in the first stage hydraulics system during the flight, causing it to fail completely. The second stage recovered from the violent maneuvering this failure caused at separation, but at an incorrect attitude. The vehicle was destroyed 484 seconds into the flight. (U)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Pioneer 10	2 Mar 72 2049 EST	Atlas/ Centaur TE-M-364-4 (AC-27)	Pioneer F	ETR 36A	Pioneer 10's launch vehicle consisted of an Atlas SLV-3 first stage, a Centaur D second stage, and a new, spin-stabilized third stage incorporating a TE-M-364-4 solid propellant motor. For several weeks after launch, sunlight hit Pioneer 11 from the side, causing heating problems. Leaving some experiments unenergized, shielding others with screens, and pointing the spacecraft away from Earth helped to protect the instruments. On 15 July 1972 Pioneer 10 entered the asteroid belt; in February 1973 it emerged unscathed after a 435 million-km (270 million-sm) passage. It counted asteroid penetration and measured the intensity of the Zodiacal Light in interplanetary space. In August 1972, Pioneer 10 measured the solar wind, its data to be correlated with those from earlier Pioneers in solar orbit near the Earth's distance from the Sun. On 3 December 1973, Pioneer 10 made its closest approach to within 130,354 km (81,000 sm) of Jupiter's cloud tops--at a speed of 132,000 km (82,000 sm) per hour. During encounter, Pioneer 10 missed only one objective because of false commands triggered by Jupiter's intense radiation. Pioneer 10 discovered plasma in Jupiter's magnetic field; and returned images of the planet in red and blue, which were later processed into nearly true-color pictures. The 258-kg (569-lb) Pioneer 10 will cross Pluto's orbit in 1983 and continue at 40,000 km (25,000 sm) per hour into interstellar space. (S)

Pioneer 10 Firsts

Pioneer 10 was the first spacecraft to fly beyond the orbit of Mars; to penetrate and cross the asteroid belt; to provide "in situ" measurements of Jupiter's environment; and to take close-up pictures of Jupiter. It was also the first NASA spacecraft to use all-nuclear electrical power and be capable of operating beyond the influence of the Sun. Pioneer 10 will become the first human-made object to leave this solar system.

Interstellar Stela

Attached to Pioneer 10 is a plaque with a message for extraterrestrial intelligences, should the spacecraft ever be found by them. The message, designed by Drs. Carl Sagan and Frank Drake, pictures two humans, male and female, and tells when and where the species lived. The design is etched into a gold anodized aluminum plate, which measures 15.25 x 22.8 x 0.127 cm (6 x 9 x 0.050 inches).

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Pioneer 11	5 Apr 73 2111 EST	Atlas/ Centaur TE-M-364-4 (AC-30)	Pioneer-G	ETR 36B	The 259-kg (571-lb) Pioneer 11 followed Pioneer 10 to rendezvous with Jupiter. Pioneer 11's closest approach occurred on 2 December 1974. It penetrated deeper into the radiation belts than the preceding spacecraft, to within 42,760 km (26,570 sm) of the cloud tops--3 times closer than Pioneer 10. Although it took a closer path to Jupiter, it went straight up through the radiation belts and thus reduced exposure time. Its total radiation dose was not as great as Pioneer 10's. Approaching Jupiter, Pioneer 11 repeatedly crossed the bow shock, showing that the Jovian magnetosphere changed its boundaries as it was buffeted by the solar wind. Pioneer 11 found Jupiter's poles to be covered by a thicker but transparent atmosphere and to have lower cloud tops than the rest of the planet. Pioneer 11 used Jupiter's massive gravitational field to swing back across the solar system to encounter Saturn. Spurious commands began interfering with the operations of the asteroid/meteoroid detector, and the instrument had to be turned off in 1975. Closest approach to Saturn occurred on 1 September 1979. Pioneer 11 crossed the ring plane beyond the outer ring, then swung underneath the rings, passing a few thousand kilometers (statute miles) from them. The spacecraft came within 21,400 km (13,300 sm) of Saturn's cloud tops, at a speed of 114,100 kph (71,900 mph) at the point of closest approach. After leaving Saturn, Pioneer 11 began a course for interstellar space in a direction nearly opposite from Pioneer 10. Like Pioneer 10, Pioneer 11 also carried a plaque with a message for extraterrestrial intelligences. (S)

Pioneer 11 Firsts

Pioneer 11 was the first spacecraft to fly to Saturn and take close-up pictures of the planet. It also returned the first pictures of the polar regions of Jupiter.

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Pioneer Venus 1	20 May 78 2113 EDT	Atlas/ Centaur (AC-50)	Pioneer Venus Orbiter	ETR 36A	The Orbiter was the first spacecraft placed in orbit around Venus. It achieved orbit on 5 Dec 1978. The Orbiter supplied data for a radar map of the Venusian surface. Mountains were discovered, some higher than those on Earth. The maps exposed the largest canyon yet discovered in the solar system--a giant rift valley 4,572 meters (15,000 feet) deep, 1,448 km (900 sm) long, and up to 282 km (175 sm) wide. Observations in the infrared revealed a clearing in the planet's cloud layers over the north pole; photos in the ultraviolet showed dark markings, that spanned the visible hemisphere, in the clouds. Cameras also detected almost continuous lightning activity on Venus. (S)
Pioneer Venus 2	8 August 78 0333 EDT	Atlas/ Centaur (AC-51)	Pioneer Venus Multiprobe	ETR 36A	Launched over two months after the Pioneer Venus Orbiter, the Multiprobe arrived at the planet only five days later because of its shorter trajectory. The Multiprobe consisted of a bus (or main body) and four probes. On 9 Dec 1978, all five components entered the upper atmosphere independently. Three weeks earlier the probes had been released, to continue traveling separately. They fell through the Venusian atmosphere, radioing information on the structure and composition of the atmosphere, including temperature and pressure profiles, heat received from sunlight, and cloud structure and motion. The bus entered the atmosphere 1-1/2 hours later than the probes, in order to perform radio tracking on them as they fell. Horizontal motions of the probes, measured by tracking, provided scientific data on the Venusian winds. (S)

RANGER

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Ranger 1	23 Aug 61 0504 EST	Atlas-Agena-1	P-32	ETR 12	Lunar probe. Injected into low-Earth orbit rather than planned deep-space orbit due to failure of Agena stage to restart. Served as useful engineering test. Returned scant scientific data before re-entry on 30 August 1961. (U)
Ranger 2	18 Nov 61 0312 EST	Atlas-Agena-2	P-33	ETR 12	Lunar probe. Placed in low-Earth orbit rather than programmed deep space orbit. Test of spacecraft achieved. Re-entered 30 Nov 1961. (U)
Ranger 3	26 Jan 62 1530 EST	Atlas-Agena-3	P-34	ETR 12	United States' first attempt to rough-land separable instrumented capsule on lunar surface. Spacecraft injected into lunar transfer path at excessive velocity due to malfunction in Atlas guidance equipment. Arrived in area of the Moon approximately 14 hours early, missing it by 36,793 km (22,862 sm). Provided first measurement of interplanetary gamma ray flux. Entered solar orbit. (U)
Ranger 4	23 Apr 62 1550 EST	Atlas-Agena-4	P-35	ETR 12	First lunar impact for a U.S. payload. Put into proper lunar impact trajectory by Agena restart, but failure of timer prevented controlled descent onto Moon's surface and precluded accomplishment of engineering and scientific experiments. No mid-course corrrection. Crashed onto backside of Moon on 26 April 1962. While full flight objectives were not achieved, a high order of performance in the Atlas-Agena/Ranger combination was demonstrated. (P)

LUNAR AND PLANETARY
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Ranger 5	18 Oct 62 1159 EST	Atlas-Agena-7	P-36	ETR 12	Spacecraft launched into proper lunar impact trajectory; after 15 minutes of normal operation, malfunction caused spacecraft to transfer from solar to battery power. Normal operation never resumed; battery power supply ran down after 8 hours, rendering spacecraft systems and experiments useless. Passed within 724 km (450 sm) of Moon and on into solar orbit; was tracked to distance of 1,271,381 km (790,000 sm). (P)
Ranger 6	30 Jan 64 1049 EST	Atlas-Agena SLV-3 (Atlas-Agena-8)	Ranger-A (P-53)	ETR 12	Successful launch but mission not accomplished due to failure of TV cameras which were to transmit 3,000 pictures of the Moon at altitudes ranging from 1,448 to 6.4 km (900 to 4 sm). Ranger impacted in the Sea of Tranquility at 0424 EST on 2 February, precisely on schedule. (P)
Ranger 7	28 Jul 64 0050 EDT	Atlas-Agena SLV-3 (Atlas-Agena-9)	Ranger-B (P-54)	ETR 12	The 365.6-kg (806-lb) spacecraft, which carried six TV cameras, was successfully placed into parking orbit, and later injected into lunar trajectory by restarting the Agena motor. During the last 15 minutes of flight, the cameras sent back 4,316 high-quality photographs of the Moon's surface. The final pictures were transmitted 2.3 seconds before impact on 31 July 1964. All aspects of the test were successful. (S)
Ranger 8	17 Feb 65 0005 EST	Atlas-Agena SLV-3 (Atlas-Agena-13)	Ranger-C	ETR 12	Lunar photography. 7,137 pictures obtained; impact occurred about 24 km (15 sm) from target in Sea of Tranquility on 20 February 1965. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Ranger 9	21 Mar 65 1637 EST	Atlas-Agena SLV-3 (Atlas-Agena-14)	Ranger-D	ETR 12	Lunar photography. 5,814 pictures obtained; impact only a few kilometers (miles) from target in eastern floor of crater of Alphonsus, 24 March 1965. Pictures converted for live viewing on commercial TV. Final mission of Ranger series. (S)

SURVEYOR

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Surveyor 1	30 May 66 0941 EST	Atlas/ Centaur LV-3C (AC-10)	Surveyor-A	ETR 36A	Soft-landed on Moon in the Ocean of Storms 2 June, proving capability of launch vehicle and spacecraft. Returned thousands of high-quality pictures. Selenological data obtained in morphology and lunar origin. Completed mission 13 July but spacecraft remained operable for 8 months. (S)
Surveyor 2	20 Sep 66 0732 EST	Atlas/ Centaur LV-3C (AC-7)	Surveyor-B	ETR 36A	Intended to demonstrate soft lunar landing and provide data for Apollo program. Flight successful until midcourse maneuver, when one of three vernier engines failed to ignite, causing spin. Data obtained on spacecraft performance until it crashed on Moon 23 September. (P)
Surveyor 3	17 Apr 67 0205 EST	Atlas/ Centaur LV-3C (AC-12)	Surveyor-C	ETR 36B	Soft-landed on Moon 20 April, within Apollo landing area. Returned TV pictures and obtained data on lunar surface by digging up a sample with a claw. On basis of data, scientists concluded that lunar soil had consistency similar to wet sand, with a bearing strength of 10 psi, firm enough for Apollo LM landing. Experiments stopped 2 May when lunar night began. Surveyor 3 was visited by Apollo 12 astronauts on 20 November 1969. Some of its parts were removed and returned to Earth. (S)
Surveyor 4	14 Jul 67 0753 EDT	Atlas/ Centaur LV-3C (AC-11)	Surveyor-D	ETR 36A	Carried a surface claw similar to Surveyor 3, with a magnet in the claw to measure ferrous elements in lunar soil. Flight was successful until all communications with Surveyor 4 were lost 2 seconds before retrorocket burnout on 17 July 1967, 2-1/2 minutes before landing. Scientists theorize that Surveyor 4 spacecraft exploded. (P)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Surveyor 5	8 Sep 67 0357 EDT	Atlas/ Centaur SLV-3C (AC-13)	Surveyor-E	ETR 36B	Soft-landed on Moon in Sea of Tranquility on 11 September. Spacecraft landed on inner slope of small crater, about 9 meters (30 feet) in diameter and 1.37 meters (4-1/2 feet) deep, with the TV camera about 50.8 centimeters (20 inches) above crater's rim. Returned TV pictures of surface, some converted to color. Conducted a vernier engine experiment to investigate erosion from rocket's flame. Obtained touchdown dynamics, thermal and radar reflectivity data on lunar surface. Performed alpha scattering experiments to determine relative abundance of elements in lunar soil. Shut down for lunar night on 24 September. Restarted at a later date, but subsequent data was of lower quality. Loss of signal on 16 December 1967. (S)
Surveyor 6	7 Nov 67 0239 EST	Atlas/ Centaur SLV-3C (AC-14)	Surveyor-F	ETR 36B	Soft-landed in Sinus Medii near later Apollo Site 2 P-8 (3) 9 November after 53-hour, 22-minute flight from Earth. Transmitted over 30 thousand pictures to Earth during first lunar day of operations. Besides surveying lunar surface, also photographed Earth, Jupiter, and the stars Canopus, Capella, Sirius and Vega. Obtained data on touchdown dynamics, thermal and radar reflectivity of lunar surface, and relative abundance of chemical elements in lunar soil. On 17 November spacecraft's three vernier engines were restarted and Surveyor 6 was lifted about 4 meters (13 feet) off the lunar surface and translated a horizontal distance of about 3 meters (10 feet). Shut down for lunar night on 24 November 1967. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Surveyor 7	7 Jan 68 0130 EST	Atlas/ Centaur SLV-3C (AC-15)	Surveyor-G	ETR 36A	Last spacecraft of Surveyor series. Successfully launched from Cape Canaveral (within one second of the desired liftoff time) into a direct ascent lunar trajectory, which required only a single midcourse correction maneuver. Soft-landed near crater Tycho at 2005 EST 9 January 1968, after a flight of 66 hours, 34 minutes. Landing site (40.89° south latitude, 11.44° west longitude) was about 2.4 km (1.5 sm) from aiming point. Returned over 21,000 television pictures, including some in stereo, of lunar surface and lunar rocks of special geological interest during first lunar day operations. On two different occasions, Surveyor camera detected laser beams directed from Earth towards the spacecraft. Also, photographed Earth and Jupiter. Returned telemetry data on lunar surface, similar to Surveyors 1, 3, 5, and 6. Spacecraft was shut down for its first lunar night on 22 January 1968. (S)

LUNAR ORBITER

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Lunar Orbiter 1	10 Aug 66 1426 EST	Atlas-Agena SLV-3 (Atlas-Agena-17)	LO-A	ETR 13	First of five planned missions to explore equatorial regions of Moon to select area for Apollo landing. Put into lunar orbit at height of 188 to 1,865 kilometers (117 to 1,159 statute miles), later lowered to 40 km (25 sm) at perilune. Total of 207 frames taken; high-resolution camera picture smeared, medium-resolution excellent. Terminated by crashing into Moon on 29 October 1966 to avoid conflict with LO-2. (S)
Lunar Orbiter 2	6 Nov 66 1821 EST	Atlas-Agena SLV-3 (Atlas-Agena-18)	LO-B	ETR 13	Orbited Moon at perilune of 50 km (31 sm) and photographed 13 primary target sites for Apollo landing. Returned 205 high-resolution photos before pictures stopped 6 December (one day early), when high-power transmission ceased. Also monitored radiation in lunar environment. Crashed on lunar surface 11 October 1967. (S)
Lunar Orbiter 3	4 Feb 67 2017 EST	Atlas-Agena SLV-3 (Atlas-Agena-20)	LO-C	ETR 13	Lunar orbit at perilune of 55 km (34 sm). 211 pictures of Apollo and Surveyor sites taken (72% of planned) before malfunction in priority readout system caused termination on 24 February. Also continued LO-B experiments. Crashed on lunar surface 9 October 1967. (S)
Lunar Orbiter 4	4 May 67 1825 EDT	Atlas-Agena SLV-3 (Atlas-Agena-22)	LO-D	ETR 13	Near-polar lunar orbit. Problems with Thermal Camera Door overcome. 99% coverage of lunar face and 75% of backside. Readout of photos completed 1 June. Crashed on lunar surface 6 October 1967. (S)

LUNAR AND PLANETARY
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Lunar Orbiter 5	1 Aug 67 1833 EDT	Atlas-Agena SLV-3 (Atlas-Agena-24)	LO-E	ETR 13	Lunar orbit at 100-km (62-sm) perilune. Photographed Apollo target sites, areas of scientific interest, and backside areas not previously covered. Photo readout completed 28 August. Crashed on lunar surface 30 January 1968. (S)

MARINER

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Mariner 1	22 Jul 62 0421 EST	Atlas-Agena-5	P-37	ETR 12	Attempted Venus probe, the booster deviated from course and was destroyed by the range safety officer 290 seconds after launch. (U)
Mariner 2	27 Aug 62 0153 EST	Atlas-Agena-6	P-38	ETR 12	First spacecraft to scan another planet; passed within 34,762 km (21,600 sm) of planet Venus on 14 December and made a 42-minute instrument scan of Venusian atmosphere and surface before continuing into heliocentric orbit. Transmissions from interplanetary experiments received until 4 January 1963 from 87.4 million km (54.3 million sm) distance, establishing a new communications record. (S)
Mariner 3	5 Nov 64 1422 EST	Atlas-Agena SLV-3 (Atlas-Agena-11)	Mariner-64C	ETR 13	Planetary exploration to the vicinity of Mars. The shroud failed to jettison; battery power dropped and there was no evidence to indicate that the solar panels opened to replenish the power supply; communications were lost. In permanent heliocentric orbit. (U)
Mariner 4	28 Nov 64 0922 EST	Atlas-Agena SLV-3 (Atlas-Agena-12)	Mariner-64D	ETR 12	Planetary and interplanetary exploration. Mars trajectory. Fly-by occurred 14 July 1965 with closest approach between 8,000 and 9,660 km (five and six thousand sm). 22 pictures were taken; first Mars flyby pictures. In heliocentric orbit. During its 3.06 years of useful life Mariner 4 travelled more than 2.4 billion km (1.5 billion sm) and returned excellent data. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Mariner 5	14 Jun 67 0201 EDT	Atlas-Agena SLV-3 (Atlas-Agena-23)	Mariner-67E	ETR 12	Purpose was to conduct a single fly-by mission to Venus in 1967 to complement and extend results of Mariner 2. The 245-kg (540-lb) spacecraft passed within 4,023 km (2,500 sm) of Venus on 19 October 1967. Measured the planet's magnetic field, ionosphere, and radiation belts and temperature. In heliocentric orbit. (S)
Mariner 6	24 Feb 69 2029 EST	Atlas/ Centaur SLV-3C (AC-20)	Mariner-69F	ETR 36B	This was the first Mariner launch with the Atlas/ Centaur vehicle. This spacecraft was one of a pair (with Mariner 7) launched to perform a Mars fly-by almost together, and acquire data on the planet. Instruments included a Visual Imager, Ultraviolet Spectrometer, Infrared Spectrometer, temperature sensors, and others. The fly-by was successful and, with Mariner 7 fly-by data, obtained the most detailed data on Mars to date. In heliocentric orbit. (S)
Mariner 7	27 Mar 69 1722 EST	Atlas/ Centaur SLV-3C (AC-19)	Mariner-69G	ETR 36A	This was the second Mariner launch with the Atlas/ Centaur vehicle, and formed the second of a pair of Mariner spacecraft launched to fly by Mars almost together. The instrumentation was virtually the same as that on Mariner 6 and the spacecraft performed with equal success, flying by Mars at a different angle from its companion and obtaining data at fly-by from other areas of the planet. Both spacecraft entered heliocentric orbits after passing Mars. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Mariner 8	8 May 71 2111 EDT	Atlas/ Centaur (AC-24)	Mariner-71H	ETR 36A	Mariner-H was first of two 998-kg (2,200-lb) spacecraft intended to explore, during the 1971 opportunity, the physical and dynamic characteristics of the planet Mars from Martian orbit. Countdown of the AC-24 launch vehicle began at the scheduled time and proceeded smoothly to liftoff. Powered flight was normal until shortly after separation and ignition of the Centaur second stage, when a malfunction occurred in the Centaur flight control system. Loss of pitch control resulted in an end-over-end tumbling, causing an abnormal shutdown of the Centaur engines. The Centaur stage and the Mariner-H spacecraft reentered the atmosphere about 1,500 km (932 sm) downrange. (U)
Mariner 9	30 May 71 1823 EDT	Atlas/ Centaur (AC-23)	Mariner-71I	ETR 36B	Second of two planned Mariner Mars 71 missions. First launch attempt on 29 May was scrubbed when special flight control system checks indicated an apparent problem. Second countdown commenced on time and proceeded to liftoff after a six-minute delay caused by a faulty instrumentation ground line. Direct ascent powered flight placed spacecraft into desired heliocentric trans-Mars trajectory. On 13 Nov Mariner 9 was inserted into Martian orbit. It arrived during the middle of a planet-wide dust storm, which made surface photography impossible for several weeks. When the storm cleared Mariner-9 went to work, providing an almost complete photographic record of the entire surface of Mars. The high-resolution photographs disclosed features such as the giant mountain Olympus Mons and the huge Valles Marineris canyon system, as well as enabling cartographers to prepare the first detailed maps of Mars. The 90-day mission was extended until 1831 EDT 27 Oct 72, ending when depletion of spacecraft attitude control gas made it impossible to continue (S).

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Mariner 10	3 Nov 73 0045 EST	Atlas/ Centaur (AC-34)	Mariner-73J	ETR 36B	Primary objective of this 502.6-kg (1,108-lb) spacecraft was to explore the atmosphere, surface, and physical characteristics of the planet Mercury. Secondary objective was to perform a fly-by of Venus. Mariner 10 flew by Venus on 13 Feb 1974 with perapsis at 1301 EDT at a distance of 5,769.5 km (3,585 sm). On 29 March 1974, Mariner 10 passed within 805 km (500 sm) of Mercury, revealing a barren, heavily cratered planet which resembled Earth's moon. However, unlike the Moon, Mercury was found to have a small magnetic field and traces of a thin atmosphere. Mariner 10 went into solar orbit and encountered Mercury again on 21 Sept 1974, passing by at 48,066 km (29,867 sm). Mariner 10's hydrazine control gas ran low, so the spacecraft was maneuvered using the pressure of the solar wind on its solar arrays and disk-shaped high gain antenna. Third fly-by of Mercury took place 16 March 1975, with an approach to 327 km (203 sm). Control gas exhausted, on 24 March 1975, Mariner 10's transmitter was turned off and the mission concluded. In heliocentric orbit. (S)

Mariner 10 Firsts

First launch of any spacecraft to the planet Mercury. First mission to program one spacecraft to explore two planets; to use the gravity of one planet to slow a spacecraft and change its flight path to an encounter with a second planet; to return to its second target twice after the initial encounter; and to use the solar wind as a major means of spacecraft orientation during flight.

VIKING

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Viking 1	20 Aug 75 1722 EDT	Titan/ Centaur (Titan III-Centaur-4)	Viking-A	ETR 41	This was the first of the twin Viking spacecraft to reach Mars. Designed primarily to collect evidence for life--or the lack of it--on Mars, the spacecraft had two major parts: an Orbiter, which circled the planet, and a Lander, which descended to the surface. Both Vikings were sterilized in large ovens at KSC. A valve failure caused the first launch attempt to be scrubbed. While the appointed spacecraft awaited launch, its batteries discharged. The second spacecraft was substituted on the vehicle while the first was checked for damage--a reversal in the planned order of launch. Viking 1 entered Martian orbit on 19 June 1976. Under camera examination of the planned landing site, the location proved too rough and a new site was chosen. Orbiter 1 proceeded to map water vapor in the atmosphere, build up thermal maps, spot clouds and dust storms, and report seasonal changes. Lander 1 descended to the Martian surface on 20 July, taking air samples as it went. Once down, it surveyed its surroundings, taking high-quality photographs in three colors. The seismometer malfunctioned, but soil property and weather instruments functioned well. Earth received daily weather reports, including temperatures and wind direction and speed. The mission's major experiment was a miniature biological laboratory, which analyzed the Martian soil. Some data indicated the presence of life, but a major test for organic compounds proved negative. The puzzle remains unsolved. Lander 1 continues to transmit to Earth once a week. Orbiter 1 is taking high-resolution pictures of the surface of Mars. (S)

Viking 1 Weights

Total weight (combined spacecraft): 3,527 kg (7,775 lb)
Orbiter: 2,339 kg (5,157 lb) fully fueled
Lander: 978 kg (2,157 lb) fully fueled

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Viking 2	9 Sept 75 1439 EDT	Titan/ Centaur (Titan III-Centaur-3)	Viking-B	ETR 41	This was the second of the twin Viking spacecraft to reach Mars. It was scheduled to be launched first, but due to a battery discharge problem it had to be checked for damage and was replaced with the spacecraft slated for the second mission. Each Viking had two major parts: an Orbiter, which circled the planet, and a Lander, which descended to the surface. On 7 August 1976, Viking 2 entered Martian orbit and joined the Viking 1 Orbiter in its search for a landing site for Lander 2. A site was chosen on the edge of the polar ice-cap, where water was located and a better chance for finding life expected. Lander 2 descended to the surface on 3 Sept. Results of the biology tests performed in the robot laboratory of Lander 2 were similar to those of Lander 1--inconclusive on the question of whether life exists or has ever existed on Mars. Martian soil could contain reactants produced by bombardment of the soil by ultraviolet rays--which produce characteristics of Earth soil containing living organisms. (Earth's denser atmosphere absorbs such rays before they reach ground.) Orbiter 2 was shut down 24 July 1978, after it ran out of attitude-control gas. Lander 2 was turned off early in 1980. (S)

Viking 2 Weights

Total weight (combined spacecraft): 3,527 kg (7,775 lb)
Orbiter: 2,339 kg (5,157 lb) fully fueled
Lander: 978 kg (2,157 lb) fully fueled

VOYAGER

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Voyager 2	20 Aug 77 1029 EDT	Titan/ Centaur (Titan III-Centaur-7)	Voyager-2	ETR 41	Voyager 2 arrived at Jupiter on 9 July 1979, following a different path from Voyager 1 (see following page) that enabled it to photograph the same five moons as its predecessor from the opposite side, and at other positions in their orbits. Voyager 2 took several new photos of the ring discovered by Voyager 1, acquired new data on the clouds and their circulation patterns in the Jovian atmosphere, and obtained much new coverage of the four largest moons and tiny Amalthea. (Later analysis of photos proved a new moon exists inside the orbit of Amalthea, one not spotted by telescopes on Earth.) The photos of the four largest moons were largely of areas not covered by Voyager 1. The volcanoes on Io were still erupting, though one of the largest had stopped. Present theory is that these are primarily sulfur volcanoes, throwing up material from a layer of liquid sulfur under pressure beneath the surface. The vast amount of data accumulated by both Voyagers will require years of analysis by planetary astronomers and other scientists. Voyager 2 is scheduled to arrive at Saturn in August 1981. If Voyager 1 has been successful, Voyager 2 will be aimed to fly-by Saturn on a path that will take it to Uranus in January 1986, and possibly Neptune in September 1989. The Voyagers have already become one of the most successful unmanned planetary exploration programs conducted by NASA. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Voyager 1	5 Sept 77 0856 EDT	Titan/ Centaur (Titan III-Centaur-6)	Voyager-1	ETR 41	Voyager 1 was launched 16 days behind Voyager 2, but followed a flight path that enabled it to arrive at Jupiter first, on 5 March 1979. During the approach and fly-by Voyager 1 studied the moons Amalthea, Io, Europa, Callisto, and Ganymede, and Jupiter itself. Io proved to have live volcanoes erupting, the only known ones outside Earth. Europa has many mysterious long dark streaks crossing its surface, and few craters. Ganymede presents evidence of geologic faulting. Callisto is the most heavily cratered, and apparently has the oldest surface, of any known moon. Europa, Ganymede, and Callisto appear to have crusts that are partially ice, and may be composed of ice over a solid core. The spacecraft had a single opportunity to photograph the area where some scientists suspected a ring might be found, and it was discovered there. The atmosphere of Jupiter was intensely photographed and studied by a variety of instruments. The Great Red Spot appears to be a semi-permanent anticyclone. Material moves back and forth between the giant colored bands that ring Jupiter, in incredibly complex circulation patterns. Jupiter also displays northern lights (auroral) activity, and frequent lightning strikes. Voyager 1 studied Jupiter's huge magnetic field, the interaction between this field and the solar wind, planetary heat balance (Jupiter radiates more heat than it receives from the Sun), radio emissions, energetic ions and electrons in the magnetosphere, ultraviolet and infrared emissions, the famous "plasma torus" created by the passage of Io through the planet's magnetic field, and much more. Overall, Voyager 1 returned far more information than the two earlier Pioneers. It was then sent on its way to Saturn for a November 1980 encounter. (S)

EARTH OBSERVATIONS

METEOROLOGY

TELEVISION INFRARED OBSERVATION SATELLITE (TIROS)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
TIROS 1	1 Apr 60 0640 EST	Thor-Able-5	A-1	ETR 17A	First true meteorological satellite, weighing 122 kg (270 lb). Photographed cloud cover and transmitted over 22,000 photographs between 1 April and 17 June 1960. Demonstrated that satellites can be used to survey other surface features from space. Still in orbit--729 x 686 km (453 x 426 sm), inclination 48.4°, period 99 minutes. (S)
TIROS 2	23 Nov 60 0613 EST	Delta DM-19 (Delta-3)	TIROS-B A-2	ETR 17A	The 122-kg (270-lb) spacecraft combined infrared measurements with photography. Wide-angle photos were substandard, but useful cloud pictures and radiation data were transmitted. Spacecraft was still transmitting usable pictures a year after launch; still in orbit--700 x 603 km (429 x 375 sm), inclination 48.6°, period 98 minutes. (S)
TIROS 3	12 Jul 61 0525 EST	Delta DM-19 (Delta-5)	TIROS-C A-3	ETR 17A	The 129-kg (285-lb) spacecraft was launched during hurricane season; one camera system failed by the end of July, the other was used until December 1962. Weather Bureau reported TIROS 3 spotted 50 tropical storms during the summer of 1961. Still in orbit--807 x 735 km (501 x 457 sm), inclination 47.9°, period 100 minutes. (S)
TIROS 4	8 Feb 62 0744 EST	Delta DM-19 (Delta-7)	TIROS-D A-9	ETR 17A	All systems on the 129-kg (285-lb) spacecraft provided good data. Clarity of pictures from the new wide-angle lens was outstanding. Photos unclear after 14 June 1962. Still in orbit--834 x 704 km (518 x 437 sm), inclination 48.3°, and period 100 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
TIROS 5	19 Jun 62 0719 EST	Delta DM-19 (Delta-10)	TIROS-E A-50	ETR 17A	The 129-kg (285-lb) spacecraft entered an orbit more elliptical than planned. First to spot five of the ten major tropical storms around the world in August. Still in orbit--937 x 591 km (582 x 367 sm), inclination 58.1°, period 100 minutes. (S)
TIROS 6	18 Sept 62 0353 EST	Delta DM-19 (Delta-12)	TIROS-F A-51	ETR 17A	Launch moved up from November to cover storm season. The 127-kg (281-lb) spacecraft performed as planned. One camera failed 1 December 1962. Still in orbit--695 x 669 km (432 x 416 sm), inclination 58.3°, period 98 minutes. (S)
TIROS 7	19 Jun 63 0450 EST	Delta DSV-3B (Delta-19)	TIROS-G A-52	ETR 17B	This 135-kg (297-lb) TIROS was the first to carry an electron temperature and density probe. Still in orbit--616 x 588 km (383 x 365 sm), inclination 58.2°, period 97 minutes. (S)
TIROS 8	21 Dec 63 0430 EST	Delta DSV-3B (Delta-22)	TIROS-H A-53	ETR 17B	Eighth successful TIROS launch; the primary mission of the 120-kg (265-lb) spacecraft was to test a new experimental camera subsystem, called Automatic Picture Transmission (APT); also carried a TV camera similar to the one carried on previous TIROS satellites. Operated satisfactorily for more than 36 months. Still in orbit--735 x 695 km (457 x 432 sm), inclination 58.5°, period 99 minutes. (S)
TIROS 9	22 Jan 65 0252 EST	Delta DSV-3C (Delta-28)	TIROS-I A-54	ETR 17A	First 138-kg (305-lb) TIROS cartwheel configuration, for increased coverage of world cloud cover; elliptical polar orbit. Still in orbit--2,572 x 702 km (1,598 x 436 sm) inclination 96.4°, period 119 minutes. (S)

TIROS OPERATIONAL SATELLITE (TOS and ESSA)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
TIROS 10	1 Jul 65 2307 EST	Delta DSV-3C (Delta-32)	OT-1	ETR 17B	First Weather Bureau-funded spacecraft; spin-stabilized, 127-kg (280-lb) spacecraft with two 104° TV cameras, similar to TIROS 6. Placed in near-polar Sun-synchronous orbit to obtain more daily photo data on storm breeding areas of hurricanes and typhoons than previously available. Still in orbit--825 x 735 km (513 x 457 sm), inclination 98.2°, period 100 minutes. (S)
ESSA 1	3 Feb 66 0241 EST	Delta DSV-3C (Delta-36)	OT-3 (TOS)	ETR 17A	The 138-kg (305-lb), 18-sided satellite provided cloud coverage of the entire sunlit portion of the Earth at least once a day for operational use. First of the TIROS Operational Satellite (TOS) series funded by Environmental Science Services Administration. Still in orbit--827 x 695 km (514 x 432 sm), inclination 97.9°, period 100 minutes. (S)
ESSA 2	28 Feb 66 0858 EST	Delta DSV-3E (Delta-37)	OT-2 (TOS)	ETR 17B	Advanced 131.5-kg (290-lb) version of the cartwheel configuration. Permitted local readout of daylight cloud cover by Automatic Picture Transmission (APT) TV system. Polar, Sun-synchronous orbit; now orbiting at 1,413 x 1,352 km (878 x 840 sm), inclination 101.2°, period 113 minutes. (S)
ESSA 3	2 Oct 66 0639 EDT (0339 PDT)	Delta DSV-3E (Delta-41)	TOS-A	WTR SLC-2E	This 148-kg (326-lb) spacecraft was launched to replace ESSA 1. Near-polar, Sun-synchronous orbit. Provided daily global photographic coverage. Advanced cartwheel design. Replaced by ESSA 5, but still in orbit--1,484 x 1,384 km (922 x 860 sm), inclination 101°, period 114.5 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ESSA 4	26 Jan 67 1231 EST (0931 PST)	Delta DSV-3E (Delta-45)	TOS-B	WTR SLC-2E	The 134-kg (295-lb) spacecraft was launched into a retrograde, Sun-synchronous polar orbit. Advanced cartwheel type. Two Automatic Picture Transmission camera systems, one became inoperable on the third day because of shutter problems. Replaced ESSA 2, whose usefulness was limited by orbital drift. Still in orbit at 1,439 x 1,323 km (894 x 822 sm), inclination 102°, period 113 minutes. (S)
ESSA 5	20 Apr 67 0621 EST (0321 PST)	Delta DSV-3E (Delta-48)	TOS-C	WTR SLC-2E	The 147-kg (325-lb) spacecraft was successfully launched into a near-polar Sun-synchronous orbit. It carried two Advanced Vidicon Camera Systems to provide 24-hour global weather coverage. Turned over to ESSA 8 May. Still in orbit--1,420 x 1,352 km (882 x 840 sm), inclination 102°, period 114 minutes. (S)
ESSA 6	10 Nov 67 1253 EST (0953 PST)	Delta DSV-3E (Delta-54)	TOS-D	WTR SLC-2E	This 135.6-kg (299-lb) operational cloud mapping spacecraft was launched into an Earth-oriented, near-polar orbit to provide real-time data for weather analysis and forecasting. Launch vehicle successfully injected spacecraft into desired orbit. All spacecraft subsystems performed well. Still in orbit--1,483 x 1,406 km (921 x 874 sm), inclination 102.2°, period 115 minutes. (S)
ESSA 7	16 Aug 68 0725 EDT (0425 PDT)	Delta DSV-3N (Delta-58)	TOS-E	WTR SLC-2E	Seventh spacecraft in the TIROS Operational System (TOS) series and seventeenth in the TIROS series. ESSA 7 was successfully launched into the desired orbit. The 154-kg (340-lb) polyhedral spacecraft carried two Advanced Vidicon Camera Systems (AVCS to obtain daily global cloud photos and a flat plate radiometer to measure the heat balance of the atmosphere. Still in orbit--1,471 x 1,429 km (914 x 888 sm), inclination 101.9°, period 115 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ESSA 8	15 Dec 68 1221 EST (0921 PST)	Delta DSV-3N (Delta-62)	TOS-F	WTR SLC-2E	This was the eighth spacecraft in the TIROS Operational Satellite (TOS) series. The two-stage launch vehicle first injected the second stage and spacecraft into a transfer orbit. After a coast period the second stage was restarted, and placed the spacecraft into the desired retrograde, Sun-synchronous, near-polar orbit. This provided maximum coverage of the illuminated Earth. The 18-sided, 136-kg (300-lb), spin-stabilized spacecraft carried two Automatic Picture Transmission (APT) camera systems to transmit real-time television pictures of Earth's cloud cover. Still in orbit--1,462 x 1,411 km (908 x 877 sm), inclination 101.3°, period 115 minutes. (S)
ESSA 9	26 Feb 69 0247 EST	Delta DSV-3E (Delta-67)	TOS-G	ETR 17B	The 112-kg (247-lb) spacecraft was launched into a near-polar, Sun-synchronous orbit. Although required to perform three precise "dogleg" maneuvers to reach the orbital injection point over the Pacific Ocean, some 3,219 km (2,000 sm) southwest of Cape Canaveral, the launch vehicle performed exceptionally well. The spacecraft's orbit is so nearly Sun-synchronous that it will take over 30 years for the satellite's equator crossing time to change by one hour. The spacecraft carried two Advanced Vidicon Camera Systems (AVCS) to obtain daily global cloud photos, and a radiometer to measure the heat balance of the atmosphere. Still in orbit--1,503 x 1,423 km (934 x 884 sm), inclination 102.1°, period 115 minutes. (S)

IMPROVED TIROS OPERATIONAL SATELLITE (ITOS and NOAA)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ITOS 1 & OSCAR 5	23 Jan 70 0631 EST (0331 PST)	Delta DSV-3L-11 (Delta-76)	TIROS-M/ OSCAR-A	WTR SLC-2W	Dual launch of the prototype in a new series of operational meteorological satellites and an amateur radio operators communications satellite. First launch of Delta rocket using 6 strap-on solid motors on first stage. The Improved TIROS will provide, on a daily basis, global coverage of weather conditions; OSCAR, with a two-month operational life, was designed to provide data on communications tests between amateur radio operators. Spacecraft systems performed normally in orbit. TIROS orbital parameters are: apogee 1,476 km (917 sm), perigee 1,432 km (890 sm), inclination 101.9°, period 115 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
NOAA 1	11 Dec 70 0635 EST (0335 PST)	Delta DSV-3L (Delta-81)	ITOS-A	WTR SLC-2W	309-kg (682-lb) spacecraft, first operational (after prototype ITOS 1) second-generation meteorological satellite with three-axis stabilization and nighttime viewing capability for 24-hour global coverage. Funded by Dept. of Commerce; developed by NASA; operated by National Oceanic and Atmospheric Admin. NOAA 1 was successfully injected into 1,472 x 1,423 km (915 x 884 sm) orbit with 102° inclination and 115-minute period. Launch vehicle was two-stage Delta with six solid-propellant motors strapped to first stage and second-stage restart capability. Three of solid motors ignited at liftoff to give total thrust of 1,467,440 newtons (330,000 lb). Remaining three solids ignited 31 seconds later to extend thrust augmentation. First launch attempt terminated on 8 Nov due to second stage control system problems. Second launch attempt on 9 Dec scrubbed due to high-altitude wind conditions. Countdown resumed on 10 Dec and proceeded to lift-off. Launch vehicle also carried into orbit a Cylindrical Electrostatic Probe Experiment (CEPE) as a secondary payload attached to second stage. In near-circular orbit with apogee 1,471 km (914 sm), perigee 1,422 km (884 sm), inclination 101.9°, and period 115 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ITOS B	21 Oct 71 0732 EDT (0432 PDT)	Delta DSV-3L (Delta-86)	ITOS-B	WTR SLC-2E	Second operational spacecraft of second-generation Improved TIROS Operational Satellite (ITOS) series. Countdown proceeded normally to liftoff. Flight appeared normal through the first burn of the second stage, but at start of one-hour coast period a force resulting from a leak in the second stage oxidizer system tended to tumble the vehicle. Pitch-and-yaw jets were able to maintain proper vehicle attitude until the control gas was expended and vehicle began to tumble. Remaining vehicle functions, including second-stage second burn and spacecraft separation, occurred on schedule but orbit was not achieved. Spacecraft and Delta second stage impacted above the Arctic Circle. (U)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
NOAA 2 & OSCAR 6	15 Oct 72 1319 EDT (1019 PDT)	Delta DSV-3N (Delta-91)	ITOS-D	WTR SLC-2W	Delta-91, a two-stage launch vehicle with first stage liftoff thrust augmented by three strapped-on Castor II solid propellant motors, was originally assigned to the ITOS-C mission and had completed prelaunch checkout when a decision was made to launch ITOS-D instead of ITOS-C. Due to a conflict in priorities with the ERTS-A mission, the launch vehicle was demated from SLC-2W in late May and placed in storage until re-erection began near the end of July. Launch vehicle and spacecraft assembly and checkout proceeded normally, although the original countdown was scrubbed on 13 Oct due to an unacceptable predicted debris fallout pattern resulting from the upper level winds. The 345-kg (760-lb) NOAA-2 spacecraft was successfully placed in the desired near-polar circular orbit of 1,454 x 1,448 km (903 x 900 sm) with an inclination of 102°, a 115-minute period, and equator crossing times of 0848 and 2048 local time. The 18-kg (40-lb) OSCAR 6 amateur radio satellite, carried as a secondary payload, was injected into a similar orbit. Both spacecraft functioned normally. Both now in orbit of 1,453 x 1,447 km (903 x 899 sm), inclination 101.4°, period 115 minutes. (S)

METEOROLOGY (continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ITOS	16 Jul 73 1310 EDT (1010 PDT)	Delta DSV-3N (Delta-96)	ITOS-E	WTR SLC-2W	Countdown began on schedule and liftoff occurred within the launch window. Early stages of powered flight appeared normal, but tracking stations at Tananarive and Johannesburg failed to pick up signals at the programmed time, indicating the 345-kg (760-lb) satellite failed to reach orbit. Early flight data revealed that at approximately 270 seconds after second-stage ignition the hydraulic pump abruptly ceased output, resulting in loss of hydraulic pressure and thrust vector control. Because of this loss of control, the vehicle tumbled and did not achieve orbital velocity. (U)
NOAA 3	6 Nov 73 1202 EST (0902 PST)	Delta DSV-3N-11 (Delta-98)	ITOS-F	WTR SLC-2W	This ITOS (Improved TIROS Operational Satellite) joined the network of weather-reporting satellites operated by the National Oceanic and Atmospheric Administration. Damage to the common bulkhead of the second stage propellant tanks caused a delay in the launch from 18 October 1973 to 6 November 1973 while the second stage was replaced. NOAA was then launched into an initial orbit of 1,509 x 1,499 km (937 x 932 sm); inclination 102.8°; and period 1 hour, 56 minutes, 5 seconds. Current orbit is at the same altitude, with an inclination of 101.8° and a period of 116.1 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
NOAA 4, OSCAR 7 & Intasat	15 Nov 74 1211 EST (0911 PST)	Delta DSV-2N-11 (Delta-104)	ITOS-G	WTR SLC-2W	This was the third NOAA spacecraft which obtained quantitative measurements of the Earth's atmospheric structure, and provided information for daily weather forecasting. During prelaunch preparations, a VE 1 actuator, both first-stage actuators, and the second-stage hydraulic pump had to be removed and replaced. Rodent contamination found in the guidance section was also removed. Besides NOAA 4, the Delta vehicle also carried into orbit an amateur radio operator's satellite, OSCAR 7, and a small Spanish satellite, called Intasat. Initial orbital parameters for NOAA 4 were: orbit 1,464 x 1,454 km (909 x 904 sm); inclination 101.7°; and period 1 hour, 55 minutes. Current orbit is 1,457 x 1,444 km (905 x 897 sm), with a 101.5° inclination and a 115-minute period. (S)
NOAA 5	29 Jul 76 1307 EDT (1007 PDT)	Delta 2310 (Delta-126)	ITOS-E2	WTR SLC-2W	The 339.3-kg (748-lb) NOAA 5 was successfully injected into an orbit with an apogee of 1,522 km (946 sm) and a perigee of 1,509 km (936 sm); inclination 101.9°; and period 1 hr, 56 mins, 12 secs. NOAA 5 fulfilled two of the three objectives of the National Operational Meteorological Satellite System (NOMSS). It obtained global cloud-cover data both day and night, and also obtained global-scale quantitative measurements of the Earth's atmospheric structure to apply to numerical weather prediction. The other objective of NOMSS, continuous viewing of weather features from synchronous altitude, was fulfilled by satellites in the SMS/GOES series. In orbit at 1,523 x 1,506 km (946 x 936 sm), inclination 101.9°, period 116 minutes. (S)

NIMBUS

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Nimbus 1	28 Aug 64 0357 EDT (0057 PDT)	Thor-Agena DM-21 (Thor-Agena-3)	Nimbus-A	WTR SLC-2E	First launch in NASA program to develop and operate advanced meteorological space observatories. Premature second-stage engine cutoff resulted in an elliptical, rather than the desired circular, polar orbit. Stabilized, Earth-oriented, 376-kg (830-lb) spacecraft carried three types of sensors: Advanced Vidicon Camera System (AVCS) to provide daytime cloud cover pictures; High Resolution Infrared Radiometers (HRIR) to supply nighttime cloud cover data; Automatic Picture Transmission (APT) subsystem to furnish forecasters in remote areas with local cloud cover data only minutes after photos were taken. Instruments transmitted satisfactory data, including first nighttime weather pictures, until mechanical problems caused slow depletion of battery power, limiting useful life of satellite to 3-1/2 weeks. Re-entered 16 May 1974. (S)
Nimbus 2	15 May 66 0356 EDT (0056 PDT)	Thor-Agena (Thrust-Augmented) (Thor-Agena-6)	Nimbus-C	WTR SLC-2E	Launched into near-circular, near-polar orbit. All systems aboard 413.7 kg (912-lb) spacecraft functioned successfully. At end of first year in orbit, Nimbus 2 had maintained 3-axis, Earth-oriented stabilization and had relayed more than a million photographs. Ceased operations 17 January 1969. Still in orbit--1,176 x 1,093 km (731 x 679 sm), inclination 100.5°, period 108 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Nimbus	18 May 68 0423 EDT (0123 PDT)	Thor-Agena (Thrust-Augmented) (Thor-Agena-9)	Nimbus-B	WTR SLC-2E	First NASA launch using long-tank Thorad-Agena. Spacecraft included a radioisotope thermoelectric generator (SNAP-19), augmenting the solar conversion power supply, to assess operational capability of radioisotope power for long-life weather satellites. Also carried as a "piggyback" payload was a U.S. Army SECOR (Sequential Collation of Range) geodetic satellite. Although the solid-propellant strap-on boosters performed normally, the Thor engine began an undamped oscillation about two seconds after liftoff. The launch vehicle was destroyed by the Range Safety Officer after 121 seconds of flight when it veered beyond limits. (U)
Nimbus 3 and EGRS 13	14 Apr 69 0254 EST (13 Apr 69) (2354 PST)	Thor-Agena (Thrust-Augmented) (Thor-Agena-10)	Nimbus-B2/ SECOR	WTR SLC-2E	The fourth of seven spacecraft in the Nimbus series was essentially a repeat of the unsuccessful Nimbus-B mission. The 617-kg (1,360-lb) spacecraft was injected into a Sun-synchronous, near-circular, polar retrograde orbit. All spacecraft systems functioned successfully, including the SNAP-19 radioisotope thermoelectric generator. An Army SECOR (Sequential Collation of Range) satellite was carried as a secondary payload on the Agena stage and was also injected into orbit. SECOR was later renamed EGRS 13. Both spacecraft are still in orbit. Nimbus 3 is at 1,130 x 1,070 km (702 x 665 sm), with an inclination of 99.6°, and a period of 107 minutes. (S)

METEOROLOGY
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Nimbus 4 & TOPO 1	8 Apr 70 0318 EST (0018 PST)	Thor-Agena (Thrust-Augmented) (Thor-Agena-13)	Nimbus-D/ TOPO	WTR SLC-2E	This was a dual launch of a NIMBUS meteorological satellite, with a U.S. Army Topographic Command TOPO-A as a secondary payload. TOPO-A performed well. The NIMBUS was designed to take measurements to provide selected vertical profiles of temperature, water vapor, and ozone content of the atmosphere from ground level upward. The spacecraft operated satisfactorily in a nearly circular orbit. Still in orbit, with an apogee of 1,102 km (685 sm), a perigee of 1,091 km (678 sm), 99.6° inclination, and a 107-minute period. (S)
Nimbus 5	11 Dec 72 0256 EST (10 Dec 72) (2356 PST)	Delta DSV-3N (Delta-93)	Nimbus-E	WTR SLC-2W	Delta-93 was a two-stage launch vehicle with first-stage liftoff thrust augmented by nine strapped-on Castor II solid propellant motors. The second stage was programmed for three starts to demonstrate its multiple restart capability. Although range scheduling moved the launch date from 11 to 10 Dec (local time), no problems were encountered during countdown and liftoff occurred on schedule at the opening of the launch window. The 772-kg (1,702-lb) Nimbus 5, sixth in the series of seven research and development spacecraft designed to flight-test a variety of meteorological and other Earth observations experiments, was successfully injected into the desired Sun-synchronous, near-circular polar orbit of 1,101 x 1,089 km (684 x 676 sm) at an inclination of 100° amd a 107-minute period. Still in an orbit of 1,105 x 1,092 km (687 x 679 sm), inclination 99.8° and period 107 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Nimbus 6	12 Jun 75 0412 EDT (0112 PDT)	Delta DSV-3N-11B (Delta-111)	Nimbus-F	WTR SLC-2W	Mission of Nimbus 6 was to gather data on Earth's atmosphere and its dynamics and provide better means of weather forecasting. The spacecraft participated in the Global Atmospheric Research Program (GARP) conducted during the summer of 1975. GARP was an international effort to gather data on the upper South Atlantic ocean region, where many hurricanes originate. Nimbus 6 was placed into the planned near-Earth orbit of 1,108 x 1,106 km (688 x 687 sm) with an inclination of 99.6° and a period of 1 hour, 47 minutes, and 12 seconds. Nimbus 6's current orbital status is: apogee 1,116 km (693 sm), perigee 1,105 km (687 sm), inclination 99.9°, and period 107 minutes. (S)
Nimbus 7	24 Oct 78 0414 EDT (0114 PDT)	Delta 2910 (Delta-145)	Nimbus-G	WTR SLC-2W	Nimbus 7 was successfully launched into an orbit 954.6 x 953.6 km (593.2 x 592.5 sm); with a period of 1 hour, 44 minutes, and 8 seconds; and an inclination of 99.28°. It was the last satellite in the series which flight-tested new instruments for pollution, oceanographic, and meteorological applications. The Nimbus series contributed significantly to observation techniques incorporated in operational satellites such as GOES and TIROS. Nimbus 7, which weighed 987 kg (2,176 lb) at launch, was sent into orbit with an 89-kg (196-lb) experiment attached to the second stage of the Delta vehicle. Called CAMEO (for Chemically Active Material Ejected in Orbit), this experiment consisted of one lithium and four barium gas canisters. It released the gases at orbital altitudes, in order to study the boundary between the polar cap and the auroral belt, and to evaluate orbital velocity effects on neutral and ion clouds. Current orbit is 958 x 945 km (595 x 587 sm), inclination 99.3°, period 104 minutes. (S)

GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITES (SMS and GOES)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
SMS 1	17 May 74 0531 EDT	Delta DSV-3P-11B (Delta-102)	SMS-A	ETR 17B	SMS 1 (Synchronous Meteorological Satellite 1) was the first of two prototype geosynchronous orbit weather satellites. It was designed to (1) photograph the complete disk of the Earth every half-hour in both visible light and infrared, (2) serve as a relay for up to 10,000 unmanned environmental monitoring platforms on the ground and in the oceans, and (3) monitor solar radiation and warn of solar disturbances such as flares. Too little pressure in the liquid oxygen tank caused Delta-102's first stage to achieve lower than the planned velocity. The guidance system added 14.7 seconds end time to the first burn to compensate for the low velocity achieved by the first stage, but correct orbit was not achieved. SMS 1 was injected into a highly elliptical transfer orbit close to the predicted in perigee and inclination, but about 3,336 km (2,073 sm) below the planned apogee. Goddard controllers utilized part of the on-board attitude control system fuel, in conjunction with the usual apogee motor burn, to move the spacecraft into the proper geosynchronous orbit. SMS 1 was first stationed at 45° west longitude to participate in the Global Atmospheric Research Program, then moved to 75° west longitude to provide weather observations of the United States and adjacent ocean area. SMS 1 provided continuous day and night images of cloud cover over the United States and the Atlantic Ocean for the first time. The satellite weighed 628 kg (1,385 lb) at launch. Still orbiting at 35,790 x 35,779 km (22,239 x 22,232 sm), inclination 4.1°, and period 1,436 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
SMS 2	6 Feb 75 1704 EST	Delta DSV-3P-11B (Delta-108)	SMS-B	ETR 17B	This spacecraft was the second of the two prototype Synchronous Meteorological Satellites, which were designed to operate in geosynchronous orbit. These satellites were prototypes of the GOES (Geostationary Operational Environmental Satellite) spacecraft operated by the National Oceanic and Atmospheric Administration (NOAA). SMS 1 and 2 were also operated and controlled by NOAA after being checked out by NASA. SMS beamed weather photographs and other information directly to local weathermen at widely scattered data utilization stations and to the operations center, where it was analyzed by meteorologists there, then sent to the smaller receiver stations using the SMS as a relay. SMS tracked hurricanes, typhoons, and blizzards by the hour, providing immediate information on their location and probable path of travel. Orbiting at 35,814 x 35,757 km (22,254 x 22,218 sm), inclination 0.1°, period 1,436 minutes. (S)
GOES 1	16 Oct 75 1840 EST	Delta DSV-3P-11B (Delta-116)	GOES-A	ETR 17B	This was the first Geostationary Operational Environmental Satellite. The spacecraft in this series are physically identical to the two earlier Synchronous Meteorological Satellites, which were funded and developed by NASA. The GOESs are the operational version, funded by NOAA. GOES 1 was placed in a near-geosynchronous orbit, then turned over to NOAA and drifted to its final location, where it entered normal service. Orbiting at 35,591 x 35,566 km (22,115 x 22,100 sm), inclination 0.0°, period 1,425 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
GOES 2	16 Jun 77 0651 EDT	Delta 2914 (Delta-131)	GOES-B	ETR 17B	Second operational geosynchronous weather observer. Delta vehicle performance was normal, and placed the spacecraft in the desired transfer orbit. The apogee motor firing circularized the orbit, and the satellite entered operations under NOAA control after a 30-day checkout by NASA. Now in orbit at 35,799 x 35,780 km (22,244 x 22,233 sm), inclination 0.4°, period 1,436 minutes. (S)
GOES 3	16 Jun 78 0650 EDT	Delta 2914 (Delta-142)	GOES-C	ETR 17B	This third weather observer (SMS-1 was no longer operational) operating from geosynchronous orbit enabled the USA to free GOES 1 to become part of the five-satellite World-wide Weather Watch system, replacing a planned U.S.S.R. satellite which was not launched. In conjunction with GOES 2, GOES 3 provides full weather coverage of the entire western hemisphere, greatly improving weather forecasting and the tracking of dangerous storms and hurricanes. In geosynchronous orbit at 35,804 x 35,775 km (22,248 x 22,230 sm), inclination 0.0°. period 1,436 mins. (S)

GEOSTATIONARY METEOROLOGICAL SATELLITE (GMS)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
GMS	14 Jul 77 0639 EDT	Delta 2914 (Delta-132)	GMS	ETR 17B	This geosynchronous weather satellite, built and operated by Japan, fulfilled that nation's commitment to provide one of five World-wide Weather Watch satellites for global weather reporting. Functionally similar to the GOES and SMS series, its data can be integrated with the other WWW satellites for global-scale weather reporting and analysis. Japan assumed charge in the transfer orbit and fired the apogee motor; GMS entered the correct orbit. It is now on station over Asia. Current orbit measures 35,858 x 35,715 km (22,281 x 22,192 sm), inclination 0.7°, period 1,436 minutes. (S)

METEOSAT

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
METEOSAT	22 Nov 77 2035 EST	Delta 2914 (Delta-136)	METEOSAT	ETR 17A	This geosynchronous weather satellite was built and is operated by ESA as its contribution to the World-wide Weather Watch system of five satellites. Functionally similar to the SMS and GOES series, it provides data which can be integrated with that of Japan's GMS and the USA satellites for global weather coverage. This satellite was placed at 0.0° longitude, where it provides coverage of Africa and most of Europe. Now located at 35,811 x 35,759 km (22,316 x 22,220 sm), inclination 0.2°, period 1,436 minutes. (S)

GEODETIC EARTH ORBITING SATELLITE (GEOS)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
GEOS 1 (Explorer 29)	6 Nov 65 1339 EST	Delta DSV-3E (Delta-34)	GEOS-A	ETR 17A	First launch of a Geodetic Earth Orbiting Satellite and an improved thrust-augmented Delta; first gravity-gradient stabilized satellite, 174.6 kg (385 lb), launched by NASA. Purpose was to investigate Earth's gravitational field, to improve world-wide geodetic accuracies, and to improve positional accuracies of satellite tracking sites. Still in orbit at 2,269 x 1,119 km (1,410 x 695 sm), inclination 59.4°, period 98 minutes. (S)
PAGEOS 1	23 Jun 66 2021 EDT (1721 PDT)	Thor-Agena (Thrust-Augmented) (Thor-Agena-7)	PAGEOS A	WTR SLC-2E	Passive Geodetic Earth Orbiting Satellite. Near-circular polar orbit. Similar to Echo 1, aluminum-covered mylar balloon, 30.48-meter (100-foot) diameter, 56.7 kg (125 lb). No instruments, world-wide triangulation network by optical sightings allows very accurate mapping. Still in orbit at 4,280 x 4,172 km (2,659 x 2,592 sm), inclination 86.9°, period 181 minutes. (S)
GEOS 2 (Explorer 36)	11 Jan 68 1116 EST (0816 PST)	Delta DSV-3E (Delta-56)	GEOS-B	WTR SLC-2E	Second spacecraft of the GEOS series and fifth satellite to be launched in the National Geodetic Satellite Program (NGSP). Successfully injected into an orbit very close to that planned: 1,575 x 1,085 km (979 x 674 sm), inclination 106°, 1/2-minute period. Spacecraft was checked out and declared operational on 20 February 1968. GEOS 2 extended the investigations associated with the NGSP. Current orbit measures 1,573 x 1,080 km (997 x 671 sm), inclination 105.8°, period 112 minutes. (S)

GEODYNAMICS EXPERIMENTAL OCEAN SATELLITE (GEOS)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
GEOS 3	9 Apr 75 1950 EDT (1650 PDT)	Delta 1410 (Delta-109)	GEOS-C	WTR SLC-2W	GEOS 3, the Geodynamics Experimental Ocean Satellite, continued the Earth studies performed by GEOS 1 and 2, the Geodetic Earth Orbiting Satellites. GEOS 3 concentrated on the oceans, providing ocean wave heights, wind speeds at the air-sea interface, ocean current boundaries and velocities, and sea ice locations. GEOS 3 also demonstrated that Earth terrain contouring could be done with radar altimeter measurements from a satellite. GEOS 3 was placed in an almost perfect circular orbit, 849 x 849 km (527 x 527 sm) with an 115° inclination and a [illegible]our, 42-minute period. Still in orbit; still transmitting. Orbit now measures 863 x 821 km (536 x 510 sm), inclination 114.9°, period 102 minutes. (S)

LASER GEODYNAMIC SATELLITE (LAGEOS)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
LAGEOS 1	4 May 76 0400 EDT (0100 PDT)	Delta 2913 (Delta-123)	LAGEOS	WTR SLC-2W	Designed to be a reference point in space for ground lasers, this 411-kg (906-lb) satellite had a surface covered with 426 corner cube reflectors. LAGEOS 1 was used to measure (1) the movement of the Earth's tectonic plates, (2) motion of the Earth's polar axis and the Earth's rotation, (3) the Earth's gravity field, and (4) satellite orbital perturbations. Understanding these processes could lead to ways to predict earthquakes and locate mineral resources. LAGEOS is now orbiting at 5,946 x 5,837 km (3,695 x 3,627 sm), inclination 109.8°, period 225 minutes. (S)

EARTH OBSERVATIONS

EARTH RESOURCES TECHNOLOGY

LANDSAT (EARTH RESOURCES TECHNOLOGY SATELLITES)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
LANDSAT 1 (formerly ERTS 1)	23 Jul 72 1406 EDT (1106 PDT)	Delta DSV-3N-11 (Delta-89)	ERTS-A	WTR SLC-2W	Two-stage Delta configuration; first use of new Delta Inertial Guidance System; first use of nine strap-on solid-propellant motors on first stage. Six solids ignited at liftoff to give total sea-level thrust of 2,152,832 newtons (484,000 lb); remaining three solids programmed to ignite 39 seconds after liftoff to prolong thrust augmentation. New second stage propulsion system had two-restart capability. Liftoff occurred 12 minutes into launch window due to a hold to investigate first stage anomaly. 941-kg (2,075-ib) spacecraft, based on the Nimbus design, was injected into a near-circular orbit: 907 x 900 km (564 x 558 sm); 99° inclination; 103-minute period. On 24 Oct ERTS 1 was deemed to have achieved its primary objective of repetitively acquiring synoptic multispectral images for a period of three months, providing useful data for investigations of agriculture and forestry resources, mineral and land resources mapping and charting, and the environment. LANDSAT 1 was retired in early 1978. It is still in orbit--912 x 899 km (567 x 559 sm), inclination 98.8°, 103 minutes. (S)

EARTH RESOURCES TECHNOLOGY
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
LANDSAT 2	22 Jan 75 1256 EST (0956 PST)	Delta 2910 (Delta-107)	ERTS-B	WTR SLC-2W	Originally scheduled for launch ten days earlier, the mission was delayed for replacement and requalification of Stage 1 and 2 electronics packages. Designed to scan atmospheric and surface features in both infrared and visual spectrums, including water, atmosphere, forests and pollution, the spacecraft was successfully placed in an orbit of 919 x 904 km (572 x 561 sm). LANDSAT 2 was retired from operation in Jan 1980, because of a wear-induced failure of its primary flight control mechanism. The spacecraft surpassed its design lifetime of one year and provided environmental data for five years. As of 31 Dec 1979, its orbit measured 919 x 914 km (571 x 568 sm), inclination 99.1°, period 103 minutes. (S)
LANDSAT 3	5 Mar 78 1254 EST (0954 PST)	Delta 2910 (Delta-139)	LANDSAT-C	WTR SLC-2W	Carrying a 25.8-kg (56.8-lb) AMSAT/OSCAR 8 and a 33.8-kg (74.6-lb) PIX satellite in addition to its own package duplicating the LANDSAT 2 mission, the spacecraft was successfully placed in an orbit of 917 x 899 km (571 x 508 sm). Now orbiting at 921 x 902 km (572 x 560 sm), inclination 99°, period 103 minutes. OSCAR 8 was built by radio amateurs in the United States, Canada, West Germany, and Japan. It was developed under the auspices of the non-profit Radio Amateur Satellite Corp. in cooperation with the American Radio Relay League, Inc. OSCAR 8 carried two transponders, both of which shared the same uplink frequency of 145.9 MHz but employed different downlink frequencies of 29.4 MHz and 435.1 MHz. PIX, the Plasma Interaction Experiment, was attached to the second stage of the Delta launch vehicle, which remained in orbit. Its purpose was to develop a means for controlling detrimental interactions between high voltage systems and the space plasma environment. (S)

COMMUNICATIONS

TECHNOLOGY DEVELOPMENT

ECHO

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Echo	13 May 60 0416 EST	Delta DM-19 (Delta-1)	A-10	ETR 17A	First use of the Delta launch vehicle; attempt to orbit a 30-meter (100-foot) diameter, 60-kg (132-lb) passive reflector sphere. Second-stage autopilot failed during coast phase; third-stage engine did not fire; spacecraft did not separate from launch vehicle. (U)
Echo 1	12 Aug 60 0440 EST	Delta DM-19 (Delta-2)	A-11	ETR 17A	First passive communications satellite; the 30-meter (100-foot) diameter, 75-kg (166-lb) aluminized plastic sphere, used as a reflecting relay for global communications experiments, was largest and most visible satellite to that time. Initial orbit parameters were 1,942 km (1,207 sm) apogee and 1,753 km (1,089 sm) perigee. Slowly lost its spherical shape due to meteoroid punctures and escape of internal gases. Re-entered atmosphere 24 May 1968. (S)
Echo (Test)	15 Jan 62 0607 EST	Thor DSV-2D (Thor-337)	AVT-1 (A-12)	ETR 17A	"Project Big Shot" Applications Vertical Test No. 1, a suborbital inflation test of 243-kg (535-lb), 41-meter (135-foot) diameter sphere. Canister ejection successful, but too rapid inflation ripped balloon apart at 400 km (250 sm) altitude. All test objectives were accomplished, and capsule with movie film re-entered and was recovered. (P)
Echo (Test)	18 Jul 62 0430 EST	Thor DSV-2D (Thor-338)	AVT-2 (A-12)	ETR 17A	Inflation test of 13-story balloon, second "Project Big Shot," was successful. The 243-kg (535-lb) sphere was visible for 10 minutes from Cape Canaveral. It was the largest human-made object sent into space, the previous record being held by Echo 1. Not intended as an orbital shot, AVT-2 re-entered 27 July 1962. (S)

TECHNOLOGY DEVELOPMENT
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Echo 2	25 Jan 64 0759 EST (0459 PST)	Thor- Agena DM-21 (Thor- Agena-2)	A-12	WTR SLC-2E	Passive communications satellite, an aluminized plastic 243-kg (535-lb) balloon, 41 meters (135 feet) in diameter. International communications experiments between U.K., U.S.S.R., and U.S. Re-entered atmosphere 7 June 1969. (S)

TELSTAR

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Telstar 1	10 Jul 62 0335 EST	Delta DM-19 (Delta-11)	A-40	ETR 17B	This 77-kg (170-lb), 87.6-centimeter (34.5-inch) sphere was the world's first active communications satellite, and also the world's first commercial satellite (owned, built, and operated by AT&T, who also paid launch costs). Transmission ceased on 23 November 1962, but was restored on 4 January 1963, and continued until 21 February 1963. Still in orbit--5,649 x 941 km (3,510 x 585 sm), inclination 44.8°, period 158 minutes. (S)
Telstar 2	7 May 63 0638 EST	Delta DSV-3B (Delta-18)	A-41	ETR 17B	This 79-kg (175-lb), 87.6-cm (34.5-in) sphere, a commercial satellite, was used successfully for several communications tests, including transmission of black-and-white and color television (live and video tape), as well as voice messages between USA, France, and England. Still in orbit--10,812 x 963 km (6,718 x 598 sm), inclination 42.8°, period 225 minutes. (S)

RELAY

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Relay 1	13 Dec 62 1830 EST	Delta DSV-3B (Delta-15)	A-15	ETR 17A	This octagonal 78-kg (172-lb) spacecraft was the first active repeater communications satellite. Power supply voltage originally too low for communication experiments; voltage built up, and early in January 1963 transatlantic TV transmissions began. Still in orbit--7,438 x 1,321 km (4,622 x 821 sm), inclination 47.5°, period 185 minutes. (S)
Relay 2	21 Jan 64 1615 EST	Delta DSV-2B (Delta-23)	A-16	ETR 17B	Similar to Relay 1, but had longer expected operating time, more efficient orbit, and internal changes designed to improve operation over earlier version. The 83.3-kg (183.6-lb) spacecraft successfully transmitted television test patterns at the end of its first orbit, and performed successfully when tested on subsequent orbits. Still in orbit--7,477 x 2,024 km (4,646 x 1,258 sm), inclination 46.4, period 195 minutes. (S)

SYNCOM

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Syncom 1	14 Feb 63 0035 EST	Delta DSV-3B (Delta-16)	Syncom-A A-25	ETR 17B	First NASA attempt for near-synchronous, 24-hour orbit successful. The 39-kg (86-lb) cylindrical satellite transmitted data during launch, then went silent. Was lost until location in desired orbit was confirmed by photographs 1 March 1963. Still in orbit, but current elements not maintained. (P)
Syncom 2	26 Jul 63 0933 EST	Delta DSV-3B	Syncom-B A-26	ETR 17A	World's first satellite to achieve synchronous 24-hour orbit. Entered definite synchronous orbit over Brazil and the South Atlantic Ocean on 15 August. Reached an altitude of 35,880 km (22,300 sm) and a speed of 10,943 kph (6,800 mph), matching the Earth's rotation speed of 1,674 kph (1,040 mph) at the equator to keep it on station. Still in orbit, but current elements not maintained. (S)
Syncom 3	19 Aug 64 0715 EST	Delta DSV-3D (Delta-25)	Syncom-C A-27	ETR 17A	First launch of a Delta using strap-on solid motors (3) to increase first stage thrust. Syncom 3 was launched into preliminary orbit and later maneuvered into synchronous orbit position over the Pacific above the Equator and the International Dateline. Live TV pictures of the Olympic Games in Tokyo were transmitted to the U.S. by Syncom 3. Still in orbit, 35,883 x 35,759 km (22,297 x 22,220 sm), inclination 5.5°, period 1,437 minutes. (S)

SYMPHONIE

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Symphonie 1	18 Dec 74 2139 EST	Delta DSV-3P-11B (Delta-106)	Symphonie-A	ETR 17B	This experimental domestic communications satellite was owned by France and West Germany. Launch was slipped one day due to a drain valve being accidentally opened at the wrong time, allowing bubbles to enter the vehicle's fuel storage tank. Consequently, the tank had to be refilled. At the same time, a quick-disconnect sprang a leak and sprayed the vehicle's skin with kerosene. No damage resulted, and the quick-disconnect was replaced. Symphonie 1 entered a highly elliptical transfer orbit. The German Space Operations Center then took control and fired the apogee boost motor to insert the spacecraft into geosynchronous orbit. Symphonie had two transponders, each designed to provide a capability of relaying one color TV channel or 600 two-way telephone conversations. When the satellite entered service, it was found that its estimated TV capacity could be doubled. Each transponder could relay two color TV programs, for a total of four on the spacecraft. Current orbit measures 35,804 x 35,773 km (22,248 x 22,228 sm), inclination 0.9°, period 1,436 minutes. (S)
Symphonie 2	26 Aug 75 2142 EDT	Delta DSV-3P-11B (Delta-114)	Symphonie-B	ETR 17A	The second of the two Symphonie spacecraft owned by France and Germany, which provided the first domestic satellite communications capability for those nations. Like its predecessor, Symphonie 2 also operated in a geosynchronous orbit. Now orbiting at 35,834 x 35,738 km (22,266 x 22,207 sm), inclination 1.5°, period 1,436 minutes. (S)

COMMUNICATIONS TECHNOLOGY SATELLITE (CTS)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
CTS	17 Jan 76 1828 EST	Delta 2914 (Delta-119)	CTS	ETR 17B	CTS, the Communications Technology Satellite, was a joint effort of the United States and Canada. It successfully demonstrated the feasibility of putting more transmitting power on a satellite, thus enabling smaller and more economical ground stations to be used. CTS was the focus of a number of U.S. and Canadian experiments involving user applications. The satellite was injected into a near-geosynchronous orbit with a final position at 116° west longitude, almost directly south of Las Vegas, Nevada. Orbital parameters are: apogee 35,863 km (22,284 sm), perigee 35,706 km (22,187 sm), inclination 1.4°, period 1,436 minutes. (S)

SIRIO

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
SIRIO	25 Aug 77 1950 EDT	Delta 2313 (Delta-133)	SIRIO	ETR 17B	SIRIO was the first communications satellite owned and operated by Italy to be placed in a geosynchronous orbit. SIRIO performed propagation experiments to determine the feasibility of using a superhigh frequency range for commercial communications. It received signals at 18 GHz and retransmitted them at 12 GHz. (SIRIO was similar to the U.S.-Canadian CTS, which received at 14 GHz and retransmitted at 12 GHz.) SIRIO also gathered data on the loss of signal strength due to adverse weather conditions such as snow, rain, or heavy fog. Current orbit: 37,049 x 34,582 km (23,021 x 21,488 sm), inclination 1.6°, period 1,438 minutes. (S)

ORBITAL TEST SATELLITE (OTS)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
OTS 1	13 Sept 77 1931 EDT	Delta 3914 (Delta-134)	OTS	ETR 17A	The Orbital Test Satellite (OTS) was built by the European Space Agency (ESA) as a pre-operational version of follow-on satellites that would provide communications links between cities in ESA member nations. OTS never reached orbit; a motor in one of Delta-134's solid boosters malfunctioned and the vehicle exploded 54 seconds into the mission. (U)
OTS 2	11 May 78 1859 EDT	Delta 3914 (Delta-141)	OTS-2	ETR 17A	OTS 2 was the backup to the Orbital Test Satellite lost when Delta-134 failed (OTS 1). The primary purpose of this pre-operational spacecraft was to receive and transmit telephone and television signals while performing propagation measurements. OTS 2 carried six transponders (together with a redundant beacon) that operated at a higher than normal frequency range, receiving at 14 GHz and retransmitting at 11 GHz. OTS 2 weighed 865 kg (1,900 lb) at launch and 460 kg (1,014 lb) after burning its apogee motor propellants. It was positioned at 10° east longitude above the equator, in geosynchronous orbit. Current orbit measures 35,788 x 35,774 km (22,238 x 22,229 sm), inclination 0.4°, period 1,436 minutes. (S)

JAPAN/CS

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Japan/CS	14 Dec 77 1947 EST	Delta 2914 (Delta-137)	CS	ETR 17B	Japan/CS, the Medium-Capacity Communications Satellite for Experimental Purposes, was funded by NASDA (National Space Development Agency of Japan). Its purpose was to explore the utilization of the higher frequency ranges, which were not crowded with commercial radio traffic. Operating in a geosynchronous orbit, Japan/CS carried six K-band transponders, which received ground transmissions at 30 GHz and retransmitted them at 20 GHz, and two C-band transponders, which received at 6 GHz and retransmitted at 4 GHz. The satellite's antenna horn featured a new design which directed signals to the assigned territory without impinging on neighboring countries. This spacecraft weighed 676 kg (1,490 lb) at launch, and 339 kg (747 lb) after burning the apogee motor propellants. It was stationed at 135° east longitude. Orbital parameters: 35,839 x 35,750 km (22,269 x 22,214 sm), inclination 0.1°, period 1,437 minutes. (S)

JAPAN/BSE

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Japan/BSE	7 Apr 78 1701 EST	Delta 2914 (Delta-140)	BSE	ETR 17B	The Japanese Medium-Scale Broadcasting Satellite for Experimental Purposes (BSE) was designed to develop the higher K-band frequencies not in commercial use. Its three K-band channels received at 14 GHz and retransmitted at 12 GHz. BSE conducted experiments in relaying color television signals on K-band directly to home receiving sets in Japan. Owned and operated by Japan's National Space Development Agency, BSE was stationed in a geosynchronous orbit at 110° east longitude. Orbit measures 35,788 x 35,774 km (22,238 x 22,229 sm), inclination 0.1°, period 1,436 minutes. (S)

COMMUNICATIONS

OPERATIONAL SYSTEMS

INTERNATIONAL TELECOMMUNICATIONS SATELLITE CONSORTIUM (INTELSAT)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat I (Early Bird)	6 Apr 65 1848 EST	Delta DSV-3D (Delta-30)	EB-A	ETR 17A	First commercial satellite launched by NASA for COMSAT Corporation on a reimbursable basis; up to 140 voice channels, television or high-speed data between North America and Europe. Still in orbit over Atlantic, 27.5° west longitude. Orbital parameters are: 35,900 x 35,675 km (22,307 x 22,167 sm), inclination 11.4°, period 1,436 minutes. (S)
Intelsat II (Lani Bird)	26 Oct 66 1805 EST	Delta DSV-3E (Delta-42)	F-1	ETR 17B	Purpose of Intelsat II program was to place two separately launched spacecraft in 24-hour synchronous orbits for communications use. F-1 was to be the Pacific satellite. Named by the Hawaiian press; "Lani" meant "bird of heaven." Launched by NASA under contract with COMSAT, the apogee motor had a short burn, giving the satellite an elliptical rather than a stationary orbit. Was usable for communications about 12 hours a day. Still in orbit--37,195 x 3,187 km (23,112 x 1,980 sm), inclination 17.6°, period 718 minutes. (S)
Intelsat II	11 Jan 67 0555 EST	Delta DSV-3E (Delta-44)	F-2	ETR 17B	Third COMSAT commercial satellite, launched to take the place of Intelsat II F-1. Entered into geostationary orbit over the Pacific (176° east longitude), it provided communications for NASA and commercial users. Still in orbit--35,782 x 35,756 km (22,234 x 22,218 sm), inclination 1.6°, period 1,435 minutes. (S)
Intelsat II	22 Mar 67 2030 EST	Delta DSV-3E (Delta-47)	F-3	ETR 17B	Fourth COMSAT commercial satellite. Placed in geostationary orbit over the Atlantic at 5° west longitude for communication service between North and South America and Europe. Still in orbit. (S)

OPERATIONAL SYSTEMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat II	27 Sep 67 2045 EST	Delta DSV-3E (Delta-52)	F-4	ETR 17B	Fifth commercial communications satellite. Launched by NASA for COMSAT to supplement and back-up Intelsat II F-2. Still in near geostationary orbit over Pacific at about 176° east longitude. Orbital parameters are: 35,783 x 35,740 km (22,224 x 22,208 sm), inclination 2.5°, period 1,435 minutes. (S)
Intelsat III	18 Sep 68 2009 EDT	Delta DSV-3M (Delta-59)	III-A	ETR 17A	First of several spacecraft planned to improve global communication network. Intelsat IIIs were designed to more than double telecommunication service to all areas of the world via active satellite. Liftoff was normal, but at 102 seconds into the flight a malfunction developed in the pitch rate system in the first stage autopilot. The space vehicle was destroyed by the Range Safety Officer 108 seconds into the flight. The trouble was diagnosed as an intermittent electrical signal in the autopilot system. This was the first of the long tank Delta configuration to be launched from the ETR. (U)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat III	18 Dec 68 1932 EST	Delta DSV-3M (Delta-63)	F-2	ETR 17A	Successfully launched for COMSAT Corporation into a temporary elliptical orbit with an apogee of 36,725 km (22,820 sm) and perigee of 262 km (163 sm), at an inclination to the equator of 30°. Its apogee kick motor was fired on 20 December and maneuvered it into a synchronous orbit over the Atlantic equator, at 31° west longitude and an altitude of 35,727 km (22,200 sm). All systems functioned normally. The second of the Intelsat III series (the first to be successfully orbited), the 287-kg (632-lb) cylindrical spacecraft had the capability of handling 1,200 two-way voice channels or four television channels. Began commercial use on Christmas Eve with scenes of Pope Paul VI celebrating midnight mass in Italy. Relayed commercial TV coverage of the Apollo 8 mission. Still in orbit--35,823 x 35,775 km (22,259 x 22,230 sm), inclination 1.4°, period 1,437 minutes. (S)
Intelsat III	5 Feb 69 1939 EST	Delta DSV-3M (Delta-66)	F-3	ETR 17A	Successfully launched for COMSAT Corporation into an elliptical orbit, with an apogee of 36,104 km (22,434 sm), a perigee of 266 km (165 sm), inclination of 29°, and a period of 638 minutes. The kick motor was later fired to place the spacecraft in a near-synchronous orbit over the Pacific Ocean. The second Intelsat III to be successfully orbited, the 291-kg (642-lb) spacecraft had the capability of handling 1,200 two-way voice circuits, or television, teletype, facsimile, and digital transmission. Repositioned over Indian Ocean at 62.5° east longitude and began service there on 1 July 1969. Current orbital parameters are: 35,804 x 35,768 km (22,248 x 22,225 sm), inclination 6°, period 1,436 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat III	21 May 69 2200 EST	Delta DSV-3M (Delta-68)	F-4	ETR 17A	Successfully launched for COMSAT Corporation into an elliptical orbit, with an apogee of 36,896 km (22,926 sm), a perigee of 280 km (174 sm), inclination of 29°, and a period of 656 minutes. The kick motor was fired on 23 May and placed the spacecraft in a near-synchronous orbit over the Pacific Ocean. After it was on station the F-3 satellite was moved until it assumed a new position over the Indian Ocean. This spacecraft had the capability of handling 1,200 two-way voice circuits, or television, teletype, facsimile, and digital transmission. Still in orbit--35,794 x 35,791 km (22,241 x 22,239 sm), inclination 1.2°, period 1,436 minutes. (S)
Intelsat III-E	25 Jul 69 2206 EDT	Delta DSV-3M (Delta-71)	F-5	ETR 17A	This was the fifth Intelsat spacecraft launched for the COMSAT Corporation. Vehicle performance was normal during the burn of the first two stages. No data was acquired during the third stage burn because the spacecraft was not radiating and the third stage was not instrumented. The spacecraft was temporarily lost to ground stations, and when found, both the third stage and spacecraft were in unplanned low orbits. Still in orbit--3,508 x 267 km (2,180 x 166 sm), inclination 30.3°, period 128 minutes. (U)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat III	14 Jan 70 1916 EST	Delta DSV-3M (Delta-75)	F-6	ETR 17A	This was the sixth Intelsat III launched for the COMSAT Corporation. Vehicle performance was normal and the spacecraft was injected into a temporary orbit, with an apogee of 35,872 km (22,290 sm), a perigee of 290 km (180 sm), inclination of 28°, and a period of 634 minutes. The 293-kg (647-lb) spacecraft was placed in a near-synchronous orbit by a burn of its apogee kick motor on 16 January 1970, and began operating. Similar in capability to all preceding Intelsat III spacecraft, this was the first launch insured against failure by a commercial company. Still in orbit--35,793 x 35,787 km (22,241 x 22,237 sm), inclination 0.2°, period 1,436 minutes. (S)
Intelsat III	22 Apr 70 1946 EST	Delta DSV-3M (Delta-78)	F-7	ETR 17A	This was the seventh Intelsat III launched for the COMSAT Corporation. The 293-kg (647-lb) spacecraft was placed in a slightly low temporary orbit, with an apogee of 31,939 km (19,846 sm), a perigee of 260 km (162 sm), and an inclination of 27°. The on-board positioning motor was used to increase the apogee and align the spacecraft for firing of the apogee motor. It was fired on 24 April, and placed the spacecraft in a near-synchronous orbit, which was further improved by the positioning motor. The spacecraft was similar in capability to previous Intelsats. Still in orbit; current elements not maintained. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat III	23 Jul 70 1923 EDT	Delta DSV-3M (Delta-79)	F-8	ETR 17A	This was the last of the series III Intelsats to be launched for the COMSAT Corporation. The 293-kg (647-lb) spacecraft had the same capabilities as previous ones in the III series. The vehicle placed the spacecraft in an orbit with an apogee of 36,260 km (22,531 sm), a perigee of 261 km (162 sm), at an inclination of 28°. The apogee motor was fired on 24 July, to position the satellite in a near-synchronous orbit, and contact with the spacecraft was lost after the motor had burned for 14.5 seconds of a programmed 27 seconds. All spacecraft systems were working well up until the time the signal was lost. Still in orbit; current elements not maintained. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat IV F-2	25 Jan 71 1936 EST	Atlas/ Centaur (AC-25)	F-2	ETR 36A	AC-25 was the first flight of an uprated Atlas SLV-3C first stage with an increased liftoff thrust of 1,794,248 newtons (403,383 lb) and a longer burning time. After three earlier launch attempts (on 22, 23 and 24 Jan) were scrubbed due to upper level winds being unacceptable in shear, a fourth launch attempt was initiated on 25 Jan. During the countdown a range sequencer problem caused countdown clocks to become erratic and rendered Cape radar useless for Range Safety Command tracking. Evaluation of the problem and the decision to use Centaur telemetry to satisfy Range Safety requirements caused a planned 10-minute hold at T-5 minutes to be extended an additional 35 minutes; countdown then proceeded to liftoff. Intelsat IV F-2, first of a new series, was the largest commercial communications satellite ever launched both in weight--1,387 kg (3,058 lb)--and in communications capability (over four times the capacity of the Intelsat III series). Successfully inserted into elliptical transfer orbit; later positioned in synchronous orbit of 36,410 x 35,940 km (22,625 x 22,108 sm) over Atlantic at 25.5° west longitude. Current orbital parameters are: 35,797 x 35,777 km (22,243 x 22,231 sm), inclination 2.1°, period 1,436 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat IV F-3	19 Dec 71 2010 EST	Atlas/ Centaur (AC-26)	F-3	ETR 36A	First launch attempt failed on 18 Jan, due to surface winds exceeding launch limitations. During 19 Jan countdown, a problem with the Atlas LOX tank pressure redline values, apparently caused by faulty ground instrumentation, caused unplanned holds and required count to be recycled twice to T-5 minutes. Liftoff occurred at the opening of the second launch window. Spacecraft was placed into a highly elliptical synchronous transfer orbit, successfully completing NASA mission objectives. COMSAT later fired apogee kick motor to position spacecraft in synchronous orbit over Atlantic at 29.5° west longitude. The spacecraft was identical to the high-capacity Intelsat IV F-2 which preceded it in Jan 71. Still in orbit--35,797 x 35,779 km (22,248 x 22,232 sm), inclination 0.3°, period 1,436 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat IV F-4	22 Jan 72 1912 EST	Atlas/ Centaur (AC-28)	F-4	ETR 36B	Launch was rescheduled from 19 to 22 Jan to allow COMSAT to evaluate the RF systems aboard Intelsat IV F-2 to determine if a generic problem existed. Count proceeded until planned hold at T-10 minutes when it became necessary to reconfirm upper level wind shear data. Also, surface wind gusts began to exceed allowable launch parameters and lightning was forecast for the area at T-0. After 11-minute hold, count was picked up and proceeded until LOX tanking securing, when surface wind gusts again approached redlines. It was decided that time to launch was much shorter than time necessary to detank and count was continued to liftoff. Spacecraft placed into desired highly elliptical transfer orbit. COMSAT later successfully fired apogee motor to maneuver satellite into synchronous orbit on station over Pacific at 174° east longitude. Still in orbit--35,800 x 35,770 km (22,245 x 22,226 sm), inclination 0.3°, period 1,436 minutes. (S)
Intelsat IV F-5	13 Jun 72 1753 EDT	Atlas/ Centaur (AC-29)	F-5	ETR 36B	Terminal countdown commenced on time and proceeded without incident to a liftoff at the opening of the launch window. Spacecraft was placed into an elliptical 42,281 x 6,918 km (26,273 x 4,298 sm) transfer orbit, successfully completing NASA mission objective. COMSAT fired the kick motor as the spacecraft reached its third apogee, to place the satellite into geosynchronous orbit over the Indian Ocean at 62° east longitude. Still in orbit at 35,796 x 35,781 km (22,243 x 22,233 sm), inclination 0.0°, period 1,436 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat IV F-7	23 Aug 73 1757 EDT	Atlas/ Centaur (AC-31)	F-7	ETR 36A	Countdown began on schedule and proceeded normally until tower removal, which was delayed due to an anticipated thunderstorm in the launch area. Count was picked up when the thunderstorm failed to appear and continued to liftoff. All flight events occurred as expected and the 1,406-kg (3,100-lb) spacecraft was injected into a 42,334 x 6,928 km (26,308 x 4,304 sm) transfer orbit, achieving the NASA mission objective. Spacecraft's apogee kick motor was fired by COMSAT Corp. on 25 August and geosynchronous orbit was achieved. Satellite is positioned over Atlantic at 30° west longitude. Still in orbit--35,794 x 35,779 km (22,241 x 22,232 sm), inclination 0.0°, period 1,436 minutes. (S)
Intelsat IV F-8	21 Nov 74 1844 EST	Atlas/ Centaur (AC-32)	F-8	ETR 36B	Intended as a backup and replacement unit in the existing television, telephone and data transmission satellite system, Intelsat IV was launched without significant problems or delays, achieved initial orbit and was transferred to its final orbit of 35,802 x 35,772 km (22,246 x 22,228 sm) over the Pacific Ocean. Current orbit is 35,804 x 35,773 km (22,248 x 22,228 sm, inclination 0.0°, period 1,436 minutes. (S)
Intelsat IV F-6	20 Feb 75 1835 EST	Atlas/ Centaur (AC-33)	F-6	ETR 36A	Intended to provide an expansion of the in-orbit capacity of the Intelsat communications satellite system, the spacecraft and Centaur stage were destroyed by the Range Safety Officer 414 seconds after launch. Flight was uneventful until booster staging, when failure of an Atlas booster staging connector to disconnect set off a series of problems causing the vehicle to go effectively out of control. The Centaur second-stage ignition and burn were as planned, but failed to achieve planned velocity and course. (U)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat IV F-1	22 May 75 1804 EDT	Atlas/ Centaur (AC-35)	F-1	ETR 36A	The last of the Intelsat IV series, and originally intended as a ground spare, the spacecraft was launched after the failure of AC-33 with the Intelsat IV (F-6). The telecommunications satellite was orbited as backup to the six Intelsats in service. A second burn of the Centaur stage placed the spacecraft in a highly elliptical transfer orbit. Firing of the kick motor injected the satellite into near-geosynchronous orbit of 35,796 x 35,778 km (22,243 x 22,231 sm) as of 30 April 1975. Current orbit is 35,798 x 35,776 km (22,244 x 22,230 sm), inclination 0.0°, and period of 1,436 minutes. (S)
Intelsat IV-A F-1	25 Sep 75 2017 EDT	Atlas/ Centaur (AC-36)	F-1	ETR 36B	This was the first Intelsat IV-A, designed to increase the capacity of the orbiting communications satellite network, which was fast becoming saturated. Seven meters (23 feet) tall and weighing 792 kg (1,745 lb) after burnout of the apogee motor, it was the largest communications spacecraft ever built, with nearly double the capacity of an Intelsat IV. The satellite was injected into an elliptical transfer orbit, after which its apogee motor was fired to transfer it into a near-synchronous orbit. It then drifted to its assigned station of 25° west longitude. Its current orbit is 35,801 x 35,775 km (22,246 x 22,230 sm), inclination 0.1°, period 1,436 minutes. (S)
Intelsat IV-A F-2	29 Jan 76 1856 EST	Atlas/ Centaur (AC-37)	F-2	ETR 36B	Second in the series of second generation Intelsat commercial communications satellites, the spacecraft was launched into orbit, then moved to final position at 330.5° east longitude on 8 April, adding 20 television channels or 6,000 two-way telephone circuits to the system. Orbit measures 35,798 x 35,776 km (22,244 x 22,230 sm), inclination 0.1°, period 1,436 minutes. (S)

OPERATIONAL SYSTEMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat IV-A F-4	26 May 77 1747 EDT	Atlas/ Centaur (AC-39)	F-4	ETR 36A	Launched into a highly elliptical transfer orbit without incident and moved into geosynchronous orbit, the 825-kg (1,818-lb) spacecraft was drifted to operating position at 20° west longitude where it added needed capacity to the Atlantic segment of the Intelsat system, functioning at an altitude of 35,900 km (22,307 sm). Current orbital status is: 35,795 x 35,778 km (22,242 x 22,231 sm), inclination 0.0°, period 1,436 minutes. (S)
Intelsat IV-A F-5	29 Sep 77 2103 EDT	Atlas/ Centaur (AC-43)	F-5	ETR 36A	Intended for service over the Indian Ocean to meet anticipated increases in demand in 1978, the spacecraft was destroyed when a catastrophic failure occurred in the first stage Atlas launch vehicle at T-plus-55 seconds, and the Centaur was destroyed. (U)
Intelsat IV-A F-3	6 Jan 78 1915 EST	Atlas/ Centaur (AC-46)	F-3	ETR 36B	The fifth launch of an Intelsat IV-A, the F-3 spacecraft was successfully placed in highly elliptical transfer orbit. Successful firing of the apogee motor moved the satellite into geosynchronous orbit where it was drifted to its final station at 65° east longitude, over the Indian Ocean. Now at 35,797 x 35,780 km (22,243 x 22,233 sm), inclination 0.0°, period 1,436 minutes. (S)
Intelsat IV-A F-6	31 Mar 78 1836 EST	Atlas/ Centaur (AC-48)	F-6	ETR 36B	Sixth and last in the Intelsat IV-A series, the satellite was successfully launched into transfer orbit, and was later positioned over the Indian Ocean, at 63° east longitude, allowing the F-3 spacecraft to be moved to 60° east longitude, to serve as a spare in orbit. In orbit at 35,795 x 35,781 km (22,242 x 22,233 sm), inclination 0.1°, period 1,436 minutes. (S)

WESTAR

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Westar 1	13 Apr 74 1933 EDT	Delta DSV-3P-11B (Delta-101)	Westar-A	ETR 17B	Owned and operated in orbit by Western Union, Westar 1 became the first satellite for domestic communications in the United States. It achieved geosynchronous orbit, despite one of the nine solid rocket boosters failing to separate from the first stage when ejected. The second stage burned 23.7 seconds longer to compensate for the extra weight of the burned-out booster shell, and the third stage injected the spacecraft into its planned orbit. Westar 1 had 12 channels for commercial operation. Each relayed a mixture of various types of communications, which could total either over 1000 one-way voice circuits, or one color TV program, or up to 60 million bits of data per second. Westar 1 weighed 572 kg (1,265 lb) fully fueled prior to launch. (S)
Westar 2	10 Oct 74 1853 EDT	Delta DSV-3P-11B (Delta-103)	Westar-B	ETR 17B	Westar 2 became the second of Western Union's spacecraft in a domestic U.S. communications system. A human error in a computer caused the launch vehicle to deviate from its predicted path, but the 572-kg (1,265-lb) spacecraft was placed into its proper geosynchronous orbit. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Westar 3	9 Aug 79 2020 EDT	Delta 2914 (Delta-149)	Westar-C	ETR 17A	Built at the same time as Westars 1 and 2, Westar 3 began its career as an on-the-ground spare. But when Western Union needed to expand its system capacity, Westar 3 was sent to orbital duty. It was placed in a stationary orbit 35,807 km (22,250 sm) above the equator south of New Orleans. (S)

RCA SATCOM

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
SATCOM 1	12 Dec 75 2056 EST	Delta DSV-3P-11C (Delta-118)	SATCOM-A	ETR 17A	This satellite's launch marked the first flight of the Model 3914 Delta vehicle, a more powerful version financed by RCA in contract with McDonnell Douglas Astronautics Co. Countdown was stopped at T-7 minutes and held for nine minutes, 12 seconds for a catamaran sailboat to move out of the launch danger area. Launch was successful and the 869-kg (1,915-lb) satellite achieved geosynchronous orbit--35,789 x 35,782 km (22,239 x 22,234 sm) at a 0.0° inclination (over the equator) with a 24-hour period. Current orbit is 35,793 x 35,779 km (22,241 x 22,232 sm), inclination 0.0°, period 1,436 minutes. (S)
SATCOM 2	26 Mar 76 1747 EST	Delta DSV-3P-11C (Delta-121)	SATCOM-B	ETR 17A	Originally scheduled for 25 March, launch was slipped to permit changeout of the spacecraft yaw gyro which had exhibited an erratic drift rate. All launch vehicle and spacecraft systems performed as expected, and the RCA satellite, designed to provide commercial communications capabilities to the 50 states, was boosted to transfer orbit, then moved to synchronous equatorial Earth orbit. Current orbit is 35,797 x 35,784 km (22,243 x 22,235 sm), inclination 0.0°, period 1,436 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
SATCOM 3	6 Dec 79 2035 EST	Delta 3914 (Delta-150)	SATCOM-C	ETR 17A	Planned as the third spacecraft in RCA's satellite system for commercial communications, SATCOM 3 was lost while RCA spacecraft controllers were changing its orbit. The Delta vehicle placed the 907-kg (one-ton) spacecraft into a transfer orbit with an apogee 35,808 km (22,300 sm) above the equator. RCA controllers lost contact with SATCOM 3 during firing of its apogee kick motor to achieve geosynchronous orbit. Neither RCA nor the North American Air Defense Command were able to locate the missing satellite. (P)

U.S. MARITIME COMMUNICATIONS SATELLITE (MARISAT)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Marisat 1	19 Feb 76 1732 EST	Delta DSV-3P-11B (Delta-120)	Marisat-A	ETR 17B	This launch placed the first U.S. Maritime Communi cations Satellite in geosynchronous orbit over the Atlantic at 15° west longitude. The initial transfer orbit was circularized at 35,900 km (22,300 sm) when the on-board kick motor was fired on seventh apogee. Current orbital parameters are: 35,809 x 35,764 km (22,251 x 22,223 sm), inclination 0.7°, period 1,436 minutes. (S)
Marisat 2	9 Jun 76 2009 EDT	Delta 2914 (Delta-124)	Marisat-B	ETR 17A	Following a hold that lasted through the first launch window, to allow evaluation of lightning hazards, the second maritime communications satellite was launched into transfer orbit during the second window and, subsequently, was placed in geosynchronous orbit at 176.5° east longitude, over the Pacific basin, providing ultra-high frequency communications for the U.S. Navy, commercial shipping and offshore facilities in the Pacific. Current orbit measures: 35,815 x 35,759 km (22,254 x 22,220 sm), inclination 1.6°, period 1,436 minutes. (S)
Marisat 3	14 Oct 76 1844 EDT	Delta 2914 (Delta-127)	Marisat-C	ETR 17A	Originally designated as a ground spare, the spacecraft was launched to provide UHF maritime communications in the Indian Ocean, and to serve as a spare in orbit in the event of failure of Marisat 1 or 2. The spacecraft was placed in geosynchronous orbit of 35,793 km (22,240 sm) at approximately 73° east longitude. Current orbit is: 35,798 x 35,771 km (22,244 x 22,227 sm), inclination 0.1°, period 1,436 minutes. (S)

U.S. FLEET SATELLITE COMMUNICATIONS SPACECRAFT (FLTSATCOM)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
FLTSATCOM 1	9 Feb 78 1617 EST	Atlas/ Centaur (AC-44)	FLTSATCOM-A	ETR 36A	First in a series of military satellites designed to provide world-wide communications for the U.S. Navy, Air Force and Department of Defense (including the Presidential Command Network), the spacecraft was launched despite a hydraulics leak in the Atlas engine system. The 1,864-kg (4,132-lb) spacecraft was successfully placed in geosynchronous orbit, which now measures 35,816 x 35,756 km (22,255 x 22,218 sm) with a 0.7° inclination, and a 1,436-minute period. (S)
FLTSATCOM 2	4 May 79 1456 EDT	Atlas/ Centaur (AC-47)	FLTSATCOM-B	ETR 36A	Second in the series of military satellites linking the Command Network with the Strategic Air Command, the spacecraft did not lift off until the second day of launch opportunity, due to a possible short-circuit in the apogee motor system. With a planned life of five or more years, the satellite took its station in geosynchronous orbit. (S)

COMSTAR

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
COMSTAR D-1	13 May 76 1828 EDT	Atlas/ Centaur (AC-38)	COMSTAR D-1	ETR 36A	First of three domestic communications satellites designed for lease to American Telephone and Telegraph Corporation, the spacecraft was launched after two holds due to adverse weather and a high LOX temperature reading. Placed in geosynchronous orbit, on a trajectory identical to Intelsat IV-A, the spacecraft provided 24 simultaneous color television channels or 14,000 two-way telephone conversations. Current orbital status is: 35,794 x 35,783 km (22,241 x 22,234 sm), inclination 0.0°, period 1,436 minutes. (S)
COMSTAR D-2	22 Jul 76 1804 EDT	Atlas/ Centaur (AC-40)	COMSTAR D-2	ETR 36B	Boosted by an Atlas SLV-3D, with a Centaur D-1AR, the Hughes Aircraft-built spacecraft, weighing 1,518 kg (3,347 lb) at launch, was lofted into transfer orbit, moved into near-geosynchronous orbit, and drifted to its station at 95° west longitude. Orbit is now 35,800 x 35,776 km (22,245 x 22,230 sm), inclination 0.0°, period 1,436 minutes. (S)
COMSTAR D-3	29 Jun 78 1825 EDT	Atlas/ Centaur (AC-41)	COMSTAR D-3	ETR 36B	Launched as an in-orbit backup to COMSTAR D-1 at 128° west longitude and COMSTAR D-2 at 119° west longitude, D-3 was positioned at 131.8° west longitude, so that no more than one of the three would be in Earth's shadow or crossing the face of the Sun at once. Intended primarily for long-distance telephone service, the COMSTAR satellites weigh 811 kg (1,440 lb) in orbit. Orbit is 35,800 x 35,778 km (22,245 x 22,231 sm), inclination 0.0°, period 1,436 minutes. (S)

SKYNET

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Skynet 1	21 Nov 69 1937 EST	Delta DSV-3M (Delta-74)	Skynet-A	ETR 17A	This spacecraft, the first United Kingdom communications satellite, was successfully launched into a highly elliptical transfer orbit as planned. This launch was conducted by NASA for the U.S. Air Force, acting as agent for the United Kingdom. The apogee motor was fired on the fifth orbit by U.S. Air Force ground controllers, and placed the spacecraft in a near-synchronous orbit, with an apogee of 33,688 km (22,797 sm), perigee of 34,702 km (21,563 sm), and inclination of 26°. The spacecraft was then turned over to the United Kingdom for operation. Still in orbit, but current elements are not maintained. (S)
Skynet 2	19 Aug 70 0811 EDT	Delta DSV-3M (Delta-80)	SKynet-B	ETR 17A	This second communications satellite of the two launched for the United Kingdom, with the U.S. Air Force acting as agent, was successfully injected into a highly elliptical transfer orbit, with an apogee of 37,441 km (23,265 sm) and a perigee of 266 km (165 sm). The apogee motor was fired on the seventh orbit by U.S. Air Force ground controllers, to place the satellite in synchronous orbit. All communications with the spacecraft, both tracking and telemetry, were lost halfway through the apogee motor burn. Still in orbit, but current elements are not maintained. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Skynet	18 Jan 74 2139 EDT	Delta DSV-3P-11A (Delta-100)	Skynet II-A	ETR 17B	This third attempt to launch a United Kingdom military communications satellite with an American vehicle was the first Delta first-stage use of the uprated Rocketdyne RS-27 engine. First-stage flight performance was satisfactory, but a malfunction in the guidance system during second burn of the second stage caused the vehicle to tumble. Despite successful firing of the third-stage engine, orbit was not achieved. (U)
Skynet 3	22 Nov 74 1928 EST	Delta DSV-3P-11A (Delta-105)	Skynet II-B	ETR 17B	This military communications satellite became the United Kingdom's operational Skynet II after USAF controllers transferred it from a highly elliptical initial orbit into a near-geosynchronous orbit. The on-board engine was fired on the fifth orbit to attain an apogee of 35,792 km (22,241 sm), a perigee of 35,783 km (22,235 sm), and inclination of 1.9°. Still in orbit--35,812 x 35,776 km (22,253 x 22,230 sm), inclination 1°, period 1,436 minutes. (S)

ANIK (TELESAT)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Anik A F-1 (Telesat 1)	9 Nov 72 2014 EST	Delta DSV-3P (Delta-92)	Telesat-A	ETR 17B	First flight of three-stage Delta "Straight Eight" configuration, with full-length 2.45-meter (8-foot) diameter launch vehicle. Nine strap-on solid-propellant motors on first stage. Six motors ignited at liftoff, giving total thrust of 2,200,000 newtons (496,000 lb). Remaining strap-ons ignited 39 seconds after liftoff for extended thrust augmentation. After delays due to vehicle telemetry and GSE problems, liftoff occurred at opening of second launch window. 562-kg (1,240-lb) spacecraft, first of series of domestic communications satellites to be launched on reimbursable basis for Telesat, Canada, was injected into synchronous transfer orbit of 36,470 x 189 km (22,662 x 117 sm). Apogee motor was fired on 13 Nov to place spacecraft in synchronous orbit at 114° west longitude to provide television, radio and telephone service for all of Canada. Orbiting at 35,797 x 35,776 km (22,243 x 22,230 km), inclination 0.0°, period 1,436 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Anik A F-2 (Telesat 2)	20 Apr 73 1847 EST	Delta DSV-3P (Delta-94)	Telesat-B	ETR 17B	Second launch on a reimbursable basis for Telesat, Canada, of a domestic communications satellite. First countdown on 19 Apr was scrubbed, after a 29-minute hold at T-7 minutes, to allow for inspection of the vehicle for a missing piece of holding tape for a spacecraft connector dust cover. Second terminal count on 20 Apr proceeded to built-in hold at T-7 minutes, despite operational problems requiring personnel to be dispatched to pad area during count. Built-in hold was extended to permit alignment of countdown items with countdown clock, then extended further to permit shower to clear the launch area. Countdown then proceeded to liftoff. 566-kg (1,247-lb) spacecraft was injected into a transfer orbit of 36,480 x 212 km (22,669 x 132 sm). On 23 Apr apogee motor was fired to place spacecraft in synchronous orbit at 109° west longitude. Satellite expands Canadian television, radio, and telephone coverage initiated by Anik 1. Current orbital parameters: 35,790 x 35,784 km (22,239 x 22,235 sm), inclination 0.1°, period 1,436 minutes. (S)

OPERATIONAL SYSTEMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Anik A F-3 (Telesat 3)	7 May 75 1935 EDT	Delta DSV-3P-11B (Delta-110)	Telesat-C	ETR 17B	During launch of this domestic communications satellite, identical with Anik 1 and 2, two holds (totaling 6 minutes, 24 seconds) were necessary due to the presence first of boats, then an aircraft low on fuel in the launch danger area. Placed initially in a highly elliptical geosynchronous transfer orbit, the spacecraft was injected into a near-geosynchronous orbit, with 35,796 km (22,243 sm) apogee and perigee of 35,778 km (22,231 sm) when Telesat controllers in Canada fired the on-board engine on the seventh apogee. The spacecraft entered commercial service as part of Canada's telecommunications network. Current orbital status is 35,794 x 35,781 km (22,241 x 22,233 sm), inclination 0.0°, period 1,436 minutes. (S)
Anik B (Telesat 4)	15 Dec 78 1921 EST	Delta 3914	Telesat-D	ETR 17A	A hybrid satellite designed for internal use within Canada, Anik B differs substantially from its three predecessors. It offers 12 channels in the 6/4 GHz range, and two channels, with two backups, in the 14/12 GHz range. The lower frequencies are to supplement the existing network and/or replace older Aniks, the higher are to perform pilot projects for later 14/12 GHz satellites. Anik B is three-axis stabilized, unlike the spin-stabilized Anik 1 satellites, and much heavier at 922 kg (2,032 lb). This payload weight required the use of the 3914 Delta vehicle. Current orbital status is 35,794 x 35,782 km (22,241 x 22,234 sm), inclination 0.0°, period 1,435 minutes. (S)

NORTH ATLANTIC TREATY ORGANIZATION (NATO)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
NATOSAT 1	20 Mar 70 1852 EST	Delta DSV-3M (Delta-77)	NATO-A	ETR 17A	This was the first of two planned communications satellites to be launched for NATO. The spacecraft was injected into a highly elliptical transfer orbit, and the apogee boost motor was fired on the fifth apogee to place the satellite in a near-synchronous orbit. The spacecraft systems were checked out by the U. S. Air Force Satellite Control Facility at Sunnyvale, California, and placed in operation. Still in orbit, but current elements are not maintained. (S)
NATOSAT 2	2 Feb 71 2042 EST	Delta DSV-3M (Delta-82)	NATO-B	ETR 17A	Second of two spacecraft in NATO communications satellite program; launched by NASA on a reimbursable basis. Launch vehicle was a three-stage Delta with three solid-propellant motors strapped to first stage, giving a total liftoff thrust of 1,467,440 newtons (330,000 lb). On 25 Jan F-2 Day countdown was started, aiming for a 27 Jan launch. However, count was stopped and launch rescheduled due to a faulty velocity control system. An abbreviated countdown was resumed on 1 Feb and proceeded with one unscheduled hold to assure that ground-based radar guidance system could lock-on normally. Liftoff occurred 14 minutes behind schedule. 243-kg (535-lb) spacecraft was successfully injected into a 37,712 x 273 km (23,431 x 170 sm) synchronous transfer orbit. Apogee motor was fired 4 Feb by USAF to place spacecraft in synchronous orbit at 26° west longitude. Still in orbit, but current elements are not maintained. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
NATO III-A	22 Apr 76 1546 EST	Delta 2914 (Delta-122)	NATO III-A	ETR 17B	Using 9 strap-on Castor II solid-propellant booster motors, the Delta vehicle boosted the 701-kg (1,543-lb) satellite into transfer orbit, where the on-board kick motor placed it in near-synchronous Earth orbit over the equator. First in a new series for NATO, the satellite was designed to replace NATO II satellites, to improve free world military communications. Current orbit measures 35,794 x 35,781 km (22,241 x 22,233 sm), inclination 1.4°, period 1,436 minutes. (S)
NATO III-B	27 Jan 77 1950 EST	Delta 2914 (Delta-128)	NATO III-B	ETR 17A	Lifting off in the opening of the launch window, the Delta vehicle placed the spacecraft in a highly elliptical transfer orbit that later was modified by firing the on-board kick motor into a near-Earth synchronous orbit of 35,798 x 35,775 km (22,244 x 22,230 sm). Orbit now measures 35,791 x 35,787 km (22,239 x 22,237 sm), inclination 2.1°, period 1,436 minutes. (S)
NATO III-C	18 Nov 78 1946 EST	Delta 2914 (Delta-146)	NATO III-C	ETR 17B	Last in the series of three improved military communications satellites for NATO, the satellite was boosted into transfer orbit, then moved into Earth-synchronous orbit over the equator. Current orbital parameters are: 35,790 x 35,486 km (22,239 x 22,050 sm), inclination 4.2°, 1,429 minutes. (S)

PALAPA

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Palapa 1	8 Jul 76 1931 EDT	Delta 2914 (Delta-125)	Palapa-A	ETR 17A	The first of two domestic communications satellites launched to serve Indonesia's 3,000 islands and 120 million people, Palapa 1 was launched into transfer orbit by the three-stage Delta vehicle, then was boosted into near-synchronous orbit. Drifted to its permanent position at 83° east longitude at an altitude of 35,785 km (22,231 sm), the satellite entered service on 17 Aug. Current orbit is: 35,834 x 35,732 km (22,266 x 22,202 sm), inclination 6.2°, period 1,436 minutes. (S)
Palapa 2	10 Mar 77 1817 EST	Delta 2914 (Delta-129)	Palapa-B	ETR 17A	Designed for expansion of remote site communications, the satellite completed Indonesia's communications system when it was successfully launched and the spacecraft was placed in synchronous Earth orbit at 77° east longitude. Current orbital status is: 35,799 x 35,781 km (22,244 x 22,233 sm), inclination 0.0°, period 1,436 minutes. (S)

SPACE APPLICATIONS AND TECHNOLOGY

LAUNCH AND SPACE VEHICLE DEVELOPMENT

SATURN

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Saturn	27 Oct 61 1006 EST	Saturn C-1	SA-1	ETR 34	Successful initial flight test of first stage. Take-off thrust achieved was 5,764,608 newtons (1,296,000 lb). Hurled two water-filled, dummy upper stages, carried as ballast, to peak altitude of 136.5 km (84.8 sm) and distance of 345.5 km (214.7 sm) downrange. Reached maximum velocity of 5,804 kph (3,607 mph) before plunging into ocean 8 minutes after launch. (S)
Saturn	25 Apr 62 0901 EST	Saturn C-1	SA-2	ETR 34	Like first Saturn, fired only first-stage engines, generating 5.8 million newtons (1.3 million lb of thrust). Dummy upper stages filled with water were detonated at 104.6-km (65-sm) altitude (Project Highwater) and formed artificial cloud. All test objectives achieved. (S)
Saturn	16 Nov 62 1245 EST	Saturn C-1	SA-3	ETR 34	First stage only; coasted to 167.4-km (104-sm) altitude where it was destroyed to release 86,184 kilograms (95 tons) of water ballast into the atmosphere, forming a huge ice cloud (Project Highwater). All test objectives achieved. (S)
Saturn	28 Mar 63 1511 EST	Saturn I	SA-4	ETR 34	First stage only. One engine purposely shut off after 100 seconds to determine "engine-out" capability. Last of four first stage tests. (Launch vehicle officially designated Saturn I, on 7 February 1963.) (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Saturn	29 Jan 64 1125 EST	Saturn I	SA-5	ETR 37B	First successful test flight of the new Block II vehicles which had powered second stages. Eight H-1 engines of the first stage operated at a rated capacity of 836,224 newtons (188,000 lb) each for a total of 6,694,240 newtons (1,505,000 lb) of thrust. The six engines of the second stage ignited as planned at T-plus 149 seconds and delivered a total of 400,320 newtons (90,000 lb) of thrust. The orbited body weighed 17,100 kg (37,700 lb), nearly 9,072 kg (20,000 lb) of which was payload. During flight, eight onboard motion picture cameras and one TV camera provided the most elaborate optical instrumentation carried on a launch vehicle to date. Seven of the eight motion picture cameras that were ejected were successfully recovered. Test proved flight capability of Saturn I's liquid-hydrogen, clustered engine upper stage and demonstrated the vehicle's capability to orbit 9,072-kg (20,000-lb) payload. Re-entered 30 April 1966. (S)
Saturn	5 Jul 66 0953 EST	Uprated Saturn I (IB)	SA-203	ETR 37B	Unmanned flight to test launch vehicle second (S-IVB) stage and instrument unit (IU), which reflected Saturn V configuration. 26,536-kg (58,500-lb) payload consisting of S-IVB, IU and a nosecone (heaviest satellite orbited by U.S.) was injected into 188-km (117-sm) circular orbit. S-IVB engine burned during launch phase, then shut down. Capability of engine to restart in space demonstrated in theory. TV photos of liquid hydrogen fuel behavior in space transmitted to ground stations by camera within tank. Stage exploded on fourth orbit during test of common bulkhead when differential pressure in tanks rose well above design values. Pieces re-entered atmosphere between 5 July and 22 July 1966. (S)

CENTAUR

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Centaur	8 May 62 1449 EST	Atlas/ Centaur LV-3C (AC-1)	F-1	ETR 36A	Exploded 55 seconds after launch, apparently due to a structural failure which resulted in a fuel tank rupture. Vehicle destroyed before separation. (U)
Centaur	27 Nov 63 1403 EST	Atlas/ Centaur LV-3C (AC-2)	AC-2	ETR 36A	First successful launch of Centaur; first known ignition of liquid hydrogen-fueled rocket engines in space. Centaur did not carry an instrumented payload on this space flight. Still in orbit--1,667 x 476 km (1,036 x 296 sm), inclination 30.4°, period 107 minutes. (S)
Centaur	30 Jun 64 0904 EST	Atlas/ Centaur LV-3C (AC-3)	AC-3	ETR 36A	Failure of engine actuator hydraulic system permitted Centaur to roll, forcing propellants to sides of tanks and uncovering feed-line outlets. The two 66,720-newton (15,000-lb) thrust RL-10 engines shut down 127 seconds before programmed burning time of 380 seconds elapsed. Flight objectives which were attained included successful jettison of insulation panels and nose fairings, separation of the Atlas and Centaur stages, and demonstration of guidance system operations. AC-3 achieved maximum velocity 18,387 kph (11,425 mph) and an altitude of 555 km (345 sm). (P)
Centaur	11 Dec 64 0925 EST	Atlas/ Centaur LV-3C (AC-4)	AC-4	ETR 36A	Carried model of Surveyor spacecraft. All primary mission objectives met; however, secondary test of second burn not accomplished. Re-entered atmosphere 12 December 1964. (S)
Centaur	2 Mar 65 0825 EST	Atlas/ Centaur LV-3C (AC-5)	AC-5	ETR 36A	First attempt to place a Surveyor dynamic model into a simulated lunar transfer trajectory. Seconds after liftoff the Atlas booster failed due to the closing of a fuel-line valve. (U)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Centaur	11 Aug 65 0931 EST	Atlas/ Centaur LV-3C (AC-6)	AC-6	ETR 36B	Test for vehicle development. Fourth successful Atlas-Centaur launch; accurately put a Surveyor dynamic model into a simulated lunar trajectory; demonstrated capability of guidance system. Still in orbit; in barycentric orbit. (S)
Centaur	7 Apr 66 2000 EST	Atlas/ Centaur LV-3C (AC-8)	AC-8	ETR 36B	Vehicle development test. Seventh Atlas-Centaur development flight. Major objective; simulate lunar transfer trajectory using parking orbit, "two-burn" indirect ascent. Nominal second burn not achieved. Payload, a Surveyor mass model. Re-entered atmosphere 5 May 1966. (U)
Centaur	26 Oct 66 0612 EST	Atlas/ Centaur LV-3C (AC-9)	AC-9	ETR 36B	Final R&D of Centaur. Primary objective was re-starting of Centaur engines after a coast phase in orbit. AC-8 had failed in this. Liquid hydrogen proved satisfactory; success meant that remaining 10 vehicles in the series would be flown on operational missions. A Surveyor mass model was injected into a simulated lunar transfer orbit. Re-entered atmosphere 6 November 1966. (S)

FLIGHT INVESTIGATION OF RE-ENTRY ENVIRONMENT (FIRE)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
FIRE 1	14 Apr 64 1642 EST	Atlas-X259	--	ETR 12	First launch of Project FIRE re-entry vehicle in support of Project Apollo. Designed to investigate re-entry at escape speeds and beyond. Re-entry speed reached 36,612 kph (25,750 mph); heating reached 10,927°C (19,700°F), instead of the planned 11,027°C (19,880°F), due to lower re-entry angle of 14.5° instead of the planned nominal 15°. Impacted 322 km (200 sm) south of Ascension Island after a 32-minute flight. Test objectives achieved. (S)
FIRE 2	22 May 65 1655 EST	Atlas-X259	--	ETR 12	Re-entry test. FIRE 2 spacecraft, similar in shape to an Apollo command module, was launched into a ballistic trajectory to test re-entry heating of a spacecraft returning from the Moon. Re-entry velocity of approximately 40,234 kph (25,000 mph). Second and last flight of FIRE program. (S)

SPACE ELECTRIC ROCKET TEST (SERT)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
SERT 2	3 Feb 70 2200 EST (1900 PST)	Thor-Agena-D (Thrust-Augmented) (Thor-Agena-12)	SERT 2	WTR SLC-2E	The 1,391-kg (3,067-lb) Space Electric Rocket Test 2 (SERT 2) was successfully launched into a near-circular Sun-synchronous twilight orbit. The purpose was to verify ground test results of ion propulsion systems, determine electric propulsion engine operating characteristics in space, and develop and verify ion thruster engine operational procedures. All systems were turned on and operated normally, but ion thruster stopped operating one month short of 6-month goal and was deemed unsuccessful. Still in orbit--apogee 1,047 km (650 sm), perigee 1,039 km (646 sm), 99.1° inclination, 106-minute period. (S)

TITAN III-CENTAUR

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Titan-Centaur Proof Flight	11 Feb 74 0848 EST	Titan-III-E Centaur D	TC-1	ETR 41	This was the first launch of the Titan/Centaur vehicle, a new combination of the Air Force-developed Titan III-E vehicle and the NASA-developed Centaur upper stage. Primary purpose of this launch was to flight test the new vehicle, but it also carried two payloads. The Viking Dynamic Simulator was designed to measure the launch and flight stresses the vehicle would place on Viking spacecraft (planned for two missions to Mars in 1975). The second payload was called the Space Plasma High Voltage Interaction Experiment (SPHINX). Its objective was to investigate the effect of charged particles in space on high-voltage systems. TC-1's Centaur engines did not ignite in two attempts, because a pump failed to deliver liquid oxygen to the engines. The Range Safety Officer destructed the vehicle at T+750 seconds. (U)

APPLICATIONS TECHNOLOGY SATELLITE (ATS)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ATS 1	6 Dec 66 2112 EST	Atlas-Agena SLV-3 (Atlas-Agena-19)	ATS-B	ETR 12	First satellite in Applications Technology Satellite Program. The 351.53-kg (775-lb) satellite was placed in circular, equatorial synchronous orbit. Used for 15 separate experiments related to communications and meteorology and control technology. Still in orbit; still transmitting. Orbital parameters are: 35,798 x 35,777 km (22,244 x 22,231 sm), inclination 9.6°, period 1,436 minutes. (S)
ATS 2	5 Apr 67 2223 EST	Atlas-Agena SLV-3 (Atlas-Agena-21)	ATS-A	ETR 12	Purpose of 370-kg (815-lb) satellite was to evaluate gravity-gradient system for spacecraft stabilization. Entered elliptical transfer orbit, but failed to go into circular orbit when 2nd-stage Agena engine failed to re-ignite. Some experiments were carried out, but NASA ruled the satellite unsuccessful. Re-entered 2 September 1968. (P)

APPLICATIONS TECHNOLOGY
(Continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ATS 3	5 Nov 67 1837 EST	Atlas-Agena SLV-3 (Atlas-Agena-25)	ATS-C	ETR 12	Third in a series of Applications Technology Satellites. Contained 14 applications technology experiments concerned with communications, meteorology, stabilization and pointing technology, orbital technology, and space environmental degradation. Launch vehicle injected 714.95-kg (1,574-lb) spacecraft into highly elliptical orbit. Then, at apogee of second orbit, apogee kick motor was fired on ground command to transfer spacecraft into near-stationary equatorial orbit at approximately 35,700 km (22,200 sm) and about 47° west longitude. Transmitted excellent quality high-resolution photos of entire visible disk of Earth. Still in orbit; still transmitting. Current orbit measures: 35,863 x 35,713 km (22,284 x 22,191 sm), inclination 8.1°, period 1,436 minutes. (S)
ATS 4	10 Aug 68 1833 EDT	Atlas/ Centaur (AC-17)	ATS-D	ETR 36A	Liftoff was normal and within the desired launch window. The Centaur first burn injected the vehicle and ATS-D into a parking orbit. However, the Centaur second ignition did not occur, and attempts to separate the ATS-D from the Centaur were unsuccessful. Although the mission was a failure, the satellite attained orbit and was therefore designated ATS 4. Two cesium-propellant ion engines, developing a total thrust of 20 micro-pounds and designed for satellite positioning and station-keeping, successfully performed five separate tests totaling 23 hours firing time. Satellite and Centaur stage reentered the atmosphere on 17 October 1968. (P)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ATS 5	12 Aug 69 0701 EDT	Atlas/ Centaur (AC-18)	ATS-E	ETR 36A	After minor delays totalling 7 minutes, successfully launched spacecraft into a nominal transfer orbit. Because of unexpected large spacecraft fuel expenditure to maintain a stable spin condition, apogee kick motor was fired at first apogee rather than second one as planned. Maneuver resulted in a near-synchronous orbit with a westward drift of about 7° per day, but spacecraft began a flat spin about its yaw axis rather than prescribed rotation about its roll axis. GSFC scientists waited until spacecraft drifted into line-of-sight with ATS ground stations in U.S. on 5 September, then commanded ejection of spent apogee kick motor. Kick motor ejected but spin rate remained about 70-80 rpm, reducing usefulness of some primary experiments. Still in orbit--35,791 x 35,783 km (22,239 x 22,234 sm), inclination 5.7°, period 1,436 minutes. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ATS 6	30 May 74 0900 EDT	Titan III-C	ATS-F	ETR 40	Operating in a geosynchronous orbit, this 1,402-kg (3,090-lb) spacecraft with its 9-meter (30-foot) diameter mesh antenna, could transmit directly to small ground receiving stations. ATS 6 offered the first social experiments in health and educational telecommunications by satellite to hundreds of small communities in remote areas of the Rocky Mountain states, the Appalachian region and Alaska. In 1974, ATS 6 conducted the first educational course ever taught via satellite television, broadcasting graduate-level studies to more than 600 elementary school teachers in eight Appalachian states. ATS 6 was used in a program of decentralized medical education in the state of Washington, and through telemedicine, physicians communicated with paramedical outreach personnel in remote areas of Alaska. ATS 6 was used in the first satellite experiments for air traffic control communications. It also relayed the first satellite-to-satellite communications, proving the feasibility for a system of tracking and data relay satellites that will support Space Shuttle missions in Earth orbit. ATS was moved over Kenya for one year, where it broadcasted educational and health programs to inexpensive ground receivers in India. During the Apollo-Soyuz Test Project in July 1975, ATS 6 provided live spacecraft video to viewers in both the United States and the Soviet Union. The first full-duplex teleconferencing (two-way color TV and radio) was also accomplished with ATS-6--in a program which involved 27 lesser-developed countries and was conducted by NASA, the State Department and other federal agencies. After exceeding its planned lifetime by 3 years, ATS 6 was turned off and boosted to a higher orbit in 1979. Three of its four station-keeping thrusters had failed; if the fourth had failed, ATS 6 would have become a hazard to other spacecraft orbiting nearby. (S)

MANNED SPACE FLIGHT

MERCURY

SUBORBITAL

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Big Joe	9 Sep 59 0319 EST	Atlas-10D	Mercury-BP	ETR 14	Full-scale instrumented boilerplate model of Mercury capsule reached an altitude of 161 km (100 sm) in re-entry test. Capsule recovered after surviving re-entry heat of more than 5,537°C (10,000°F). (S)
MA-1	29 Jul 60 0913 EST	Mercury-Atlas-50D	Mercury 4	ETR 14	Launch of Mercury production capsule by an Atlas ended in failure when malfunction occurred one minute after liftoff, resulting in destruction of launch vehicle. (U)
MR-1	21 Nov 60 0900 EST	Mercury-Redstone-1 (MR-1)	Mercury 2	ETR 5	Generally not considered a launch, MR-1 rose 2.5 centimeters (one inch), stopped firing, and settled back on pad. Premature booster cutoff, triggered by faulty ground support circuitry, resulted in engine shutdown immediately after ignition, and ignition of escape tower rockets. Capsule was used again in MR-1A launch on 19 December 1960 with a different booster. (U)
MR-1A	19 Dec 60 1115 EST	Mercury-Redstone-3 (MR-3)	Mercury 2A	ETR 5	Repeat of MR-1 flight mission was successful and all major objectives fulfilled. Capsule re-entered and landed in target area 378 km (235 sm) downrange after reaching an altitude of 217 km (135 sm) and speed up to 6,920 kph (4,300 mph). Capsule recovered in excellent condition 48 minutes after launch. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
MR-2	31 Jan 61 1155 EST	Mercury-Redstone-2 (MR-2)	Mercury 5	ETR 5	Successfully launched fully equipped, operational Mercury capsule containing 16.8-kg (37-lb) chimpanzee named "Ham" on 16-minute suborbital flight to altitude of 251 km (156 sm) and over a distance of 676 km (420 sm). Excessive booster velocity carried spacecraft higher and farther than programmed, but mission objectives--flight test of capsule and its life-support system--was achieved when spacecraft and passenger were recovered in satisfactory condition. (S)
MA-2	21 Feb 61 0912 EST	Mercury-Atlas-67D	Mercury 6	ETR 14	Successful 2,293-km (1,425-sm) flight test of Mercury capsule. Atlas shutdown prematurely to simulate an abort. After separation, capsule coasted to altitude of 172 km (107 sm); automatic stabilization and control system oriented capsule for steep entry. Attained maximum velocity of 20,680 kph (12,850 mph). Landed in Atlantic Ocean 18 minutes after liftoff, sighted by search aircraft 4 minutes after landing, and recovered in excellent condition shortly thereafter. Mercury-Atlas combination functioned smoothly during severe test, which was an essential step before manned orbital flights could be attempted. (S)
MR-BD	24 Mar 61 1230 EST	Mercury-Redstone-5 (MR-5)	Mercury-BP	ETR 5	Booster development test flight to verify modifications necessitated by MR-2 flight. Modified Redstone carried boilerplate Mercury capsule to an altitude of 185 km (115 sm) and distance of 500 km (311 sm) downrange; test did not call for separation or recovery of capsule. Completely successful flight qualified Redstone for manned suborbital flights. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
MR-3	5 May 61 0934 EST	Mercury-Redstone-7 (MR-7)	Mercury 7 (Freedom 7)	ETR 5	First U.S. suborbital manned space flight. After reaching peak altitude of 187 km (116 sm) and velocity of 8,336 kph (5,180 mph), Mercury capsule, manned by astronaut Alan B. Shepard, Jr., landed in Atlantic Ocean 486 km (302 sm) downrange following 14.8-minute flight. All phases of flight were normal; astronaut and capsule recovered by helicopter within 6 minutes of landing and placed aboard recovery vessel within 11 minutes. Astronaut underwent 5 minutes of weightlessness and experienced maximum acceleration of 11 times normal gravity on re-entry. Carried out all tasks as assigned, demonstrating that a human can control a vehicle during weightlessness and high G stresses, and suffer no adverse physiological effects. (S)
MR-4	21 Jul 61 0720 EST	Mercury-Redstone-8 (MR-8)	Mercury 11 (Liberty Bell 7)	ETR 5	Second U.S. suborbital manned space flight. Spacecraft, manned by astronaut Virgil I. Grissom, made successful 15-minute, 190-km (118-sm) high, and 487-km (303-sm) flight downrange. All phases of flight were normal; however, due to inadvertent firing of explosive hatch, capsule filled with water and sank. Astronaut egressed and was recovered and, with exception of missing capsule, all mission objectives were successfully accomplished. Analysis of data indicated that all objectives of suborbital phase of Project Mercury had been achieved and no further suborbital flights were necessary. (S)

ORBITAL

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
MA-3	25 Apr 61 1115 EST	Mercury-Atlas-100-D	Mercury 8	ETR 14	Attempted orbital capsule test. Atlas did not follow programmed flight path immediately after liftoff and was destroyed by range safety action at approximately 5,000 meters (16,400 feet). Mercury capsule boosted clear of Atlas by escape tower rockets and was recovered intact. Provided thorough test of abort and recovery systems. (U)
MA-4	13 Sep 61 0904 EST	Mercury-Atlas-88D	Mercury 8A	ETR 14	Successfully completed one orbit. Capsule was recovered. Checked Mercury world-wide tracking network. (S)
MS-1	1 Nov 61 1032 EST	Mercury-Scout	Mercury-NA	ETR 18B	Destroyed by range safety action 30 seconds after liftoff. Air Force-launched: had been intended as test of global Mercury tracking network. (U)
MA-5	29 Nov 61 1008 EST	Mercury-Atlas-93D	Mercury 9	ETR 14	Scheduled three-orbit flight to test all Mercury systems. Spacecraft, carrying chimpanzee, completed two orbits when re-entry was commanded due to development of abnormal roll rate. Capsule was recovered 1 hour and 25 minutes after water landing, and well-performing "Enos" was recovered in excellent condition. (S)
MA-6	20 Feb 62 0947 EST	Mercury-Atlas-109D	Mercury 13 (Friendship 7)	ETR 14	First U.S. orbital manned space flight. Mercury spacecraft, manned by John H. Glenn, Jr., completed three orbits in 130,357-km (81,000-sm) flight lasting 4 hours, 56 minutes. Splashdown in Atlantic Ocean 267 km (166 sm) east of Grand Turk Island. Astronaut remained inside capsule until on deck of recovery vessel. Flight provided significant aerospace medical data during 285 minutes of weightlessness. Astronaut piloted spacecraft during second and third orbits due to automatic pilot difficulties. (S)

MERCURY (Continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
MA-7	24 May 62 0745 EST	Mercury-Atlas-107D	Mercury 18 (Aurora 7)	ETR 14	Second U.S. orbital manned space flight, with M. Scott Carpenter as pilot, was placed into orbit at 28,215 kph (17,532 mph). 130,679-km (81,200-sm) flight featured attitude stabilization and control pilotage for completion of three orbits. Re-entry error caused landing 322 km (200 sm) beyond intended area; astronaut egressed through top of capsule to await rescue three hours later. (S)
MA-8	3 Oct 62 0715 EST	Mercury-Atlas-113D	Mercury 16 (Sigma 7)	ETR 14	Walter M. Schirra, Jr., traveled 257,500 km (160,000 sm) in Mercury spacecraft, completing nearly six orbits and returning to Earth at predetermined point in Pacific Ocean about 9 hours, 14 minutes after launch. Safely aboard recovery vessel within 37 minutes after landing. Flight proved feasibility of prolonged weightlessness in space. (S)
MA-9	15 May 63 0804 EST	Mercury-Atlas-130D	Mercury 20 (Faith 7)	ETR 14	Astronaut L. Gordon Cooper, manning Mercury spacecraft, completed 22 orbits, traveling approximately 955,769 km (593,885 sm) in 34 hours, 20 minutes. Astronaut and spacecraft recovered only 36 minutes after splashdown in Pacific Ocean. (S)

SUBORBITAL

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Gemini 2	19 Jan 65 0904 EST	Titan II GLV-2 (GT-2)	GT-2	ETR 19	Space vehicle development. Suborbital, unmanned re-entry test at maximum heating rate; demonstrated structural integrity and systems performance of the spacecraft throughout the flight; re-entry and parachute water landing. Recovery in downrange Atlantic. (S)

ORBITAL

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Gemini 1	8 Apr 64 1100 EST	Titan II GLV-1 (GT-1)	GT-1	ETR 19	First Project Gemini flight, which tested the Titan II launch vehicle, Gemini spacecraft structural integrity, and spacecraft-launch vehicle compatibility. Spacecraft placed into orbit of 328-km (204-sm) apogee, 160-km (99.6-sm) perigee and 89.27-minute period. No separation between the 3,175-kg (7,000-lb) spacecraft and the spent rocket casing was planned; orbiting assembly re-entered the atmosphere and disintegrated about 3-1/2 days later. Test objectives achieved. (S)
Gemini 3	23 Mar 65 0924 EST	Titan II GLV-3 (GT-3)	GT-3	ETR 19	First manned Gemini. Virgil I. Grissom, Command Pilot and John W. Young, Pilot. Three orbits, 4 hours and 53 minutes in space. First use of Orbital Attitude Maneuver System. First control of re-entry flight path using maneuverable spacecraft. Spacecraft unofficially called "Molly Brown." (S)
Gemini 4	3 Jun 65 1016 EST	Titan II GLV-4 (GT-4)	GT-4	ETR 19	James A. McDivitt, Command Pilot, Edward H. White, II, Pilot. 62 orbits, a total of 97 hours and 59 minutes in space. First extravehicular activity (EVA) for 22 minutes, and the first use of personal propulsion unit (both by White). A program of eleven scientific experiments was successfully conducted. Rendezvous with booster was not achieved due to excess fuel consumption. First mission control from MSC. Recovery by USS Wasp. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Gemini 5	21 Aug 65 0900 EST	Titan II GLV-5 (GT-5)	GT-5	ETR 19	L. Gordon Cooper, Command Pilot, Charles Conrad, Pilot. 120 revolutions, a total of 190 hours, 56 minutes in space (8 days). Demonstrated physiological feasibility of lunar mission; evaluated spacecraft performance. Successfully simulated rendezvous and 16 of 17 experiments were performed. First use of the fuel cell. Recovery by the carrier, Lake Champlain. (S)
Gemini 6 Target Vahicle	25 Oct 65 1000 EST	Atlas TLV-5301 Agena TV-5002	GATV	ETR 14	Agena stage target vehicle for Gemini 6 rendezvous disintegrated at time of ignition of main Agena engine; did not orbit. Caused postponement of Gemini 6, which was later rescheduled to rendezvous with Gemini 7. (U)
Gemini 7	4 Dec 65 1430 EST	Titan II GLV-7 (GT-7)	GT-7	ETR 19	Frank Borman, Command Pilot, and James A. Lovell, Jr., Pilot. 206 revolutions, 330 hours and 35 minutes in space, the longest duration to date. The first U.S. space flight in which part of the flight was made without space suit. Used as a rendezvous vehicle for GT-6, the two coming within 1.3 meters (one foot). Landed on 18 December, 17 miles from the USS Wasp. (S)
Gemini 6A	15 Dec 65 0837 EST	Titan II GLV-6 (GT-6)	GT-6	ETR 19	Walter M. Schirra, Jr., Command Pilot, Thomas P. Stafford, Pilot. Conducted world's first rendezvous, using Gemini 7, for 5 hours, 19 minutes, approaching as near as .3 meters (one foot); reentered 16 December after 25 hours, 51 minutes. Landed within 12 miles of the USS Wasp. (S)
Gemini 8 Target Vehicle	16 Mar 66 1000 EST	Atlas TLV-5302 Agena TV-5003	GATV	ETR 14	Target vehicle available for passive rendezvous. Used as a rendezvous vehicle for Gemini 8. Reentered atmosphere 15 September 1967. (P)

GEMINI (continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Gemini 8	16 Mar 66 1141 EST	Titan II GLV-8 (GT-8)	GT-8	ETR 19	Neil A. Armstrong, Command Pilot, and David R. Scott, Pilot. 7 revolutions, 10 hours and 42 minutes in space. First dual launch and docking with the Agena target vehicle. Mission curtailed by short circuit in the Orbital Attitude Maneuvering System depleting fuel through thruster #8. Unexpected yaw and roll motion caused astronauts to undock, use their re-entry control system to stabilize the spacecraft, and re-enter on the 7th revolution instead of going the planned 44. Landing was in stipulated emergency area in the Western Pacific, 3 miles from USS Mason. Planned EVA for one orbit not achieved. (P)
Gemini 9 Target Vehicle	17 May 66 1015 EST	Atlas TLV-5303 Agena TV-5004	GATV	ETR 14	Target vehicle for GT-9. The number two Atlas engine malfunctioned, and the number one engine was unable to compensate for the pitch down attitude. The missile fell into the Atlantic. (U)
Gemini 9A Augmented Target Docking Adapter Vehicle	1 Jun 66 1000 EST	Atlas TLV-5304 Agena-ATDA	ATDA	ETR 14	Sent up in lieu of the unsuccessful GATV for GT-9. The ATDA was to be used for rendezvous and docking maneuvers. However, due to the faulty installation of separation devices, the protective shroud failed to separate from the satellite. Rendezvous later accomplished with the shroud still in place. Re-entered atmosphere 11 June 1966. (P)

GEMINI
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Gemini 9A	3 Jun 66 0840 EST	Titan II GLV-9 (GT-9)	GT-9	ETR 19	Thomas P. Stafford, Command Pilot, and Eugene A. Cernan, Pilot, were in orbit for 44 revolutions. The primary purpose was to rendezvous and dock with the GATV and to evaluate EVA. The ATDA sent up in place of the unsuccessful GATV kept its protective shroud, making docking impossible, although rendezvous was accomplished. Splashdown on 6 June, 966 km (600 sm) from Cape Canaveral, 50 km (31 sm) from the USS Wasp. (P)
Gemini 10 Target Vehicle	18 Jul 66 1540 EST	Atlas TLV-5305 Agena-TV-5005	GATV	ETR 14	Rendezvous vehicle for GT-10. Launched 100 minutes before launch of GT-10. Placed in near-circular orbit of 296 km (184 sm). Re-entered atmosphere 29 December 1966. (S)
Gemini 10	18 Jul 66 1540 EST	Titan II GLV-10 (GT-10)	GT-10	ETR 19	John W. Young, Command Pilot, with Michael Collins, Pilot. Primary purpose was to rendezvous and dock with Agena test vehicle. Secondary objectives included rendezvous with the GT-7 target vehicle. More fuel used in docking than was planned. Docking accomplished on fourth revolution. Mated spacecraft reached apogee of 766 km (476 sm), later rendezvoused with GATV of GT-8. Stand-up EVA by Collins terminated due to irritation in eyes. Umbilical EVA terminated to save fuel. Re-entered on 21 July after 43 revolutions. (S)
Gemini 11 Target Vehicle	12 Sep 66 0805 EST	Atlas TLV-5306 Agena TV-5006	GATV	ETR 14	Launched 97 minutes before GT-11. Near-circular orbit of 298 km (185 sm). Docking vehicle for GT-11. Re-entered atmosphere 30 December 1966. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Gemini 11	12 Sep 66 0942 EST	Titan II GLV-11 (GT-11)	GT-11	ETR 19	Charles Conrad, Jr., Command Pilot, Richard F. Gordon, Jr., Pilot. Achieved main goal of rendezvous on first revolution. Four practice dockings accomplished. Gordon's planned 105-minute EVA cut short after 44 minutes when prescribed tasks caused perspiration to blind his eyes. Mated spacecraft attained an apogee of 1,370 km (851 sm). Gordon took 2-hour, 8-minute standup EVA, conducting photographic experiments. GATV and GT-11 tethered by rope. Re-entry on 15 September after 71 hours, 17 minutes, 44 revolutions. Landed 3.2 km (2 sm) from target, picked up by USS Guam. (S)
Gemini 12 Target Vehicle	11 Nov 66 1408 EST	Atlas TLV-5307 Agena TV-5001	GATV	ETR 14	Target vehicle launched 98 minutes before GT-12. Went into a 254-272 km (158-169 sm) orbit. Trouble with propulsion system caused cancellation of plans to raise spacecraft (mated) apogee to 853 km (530 sm). Re-entered atmosphere 23 December 1966. (S)
Gemini 12	11 Nov 66 1547 EST	Titan II GLV-12 (GT-12)	GT-12	ETR 19	Manned orbital flight, with James A. Lovell, Jr., as Command Pilot and Edwin E. Aldrin, Jr., as Pilot. Rendezvous and docking with GATV completed on third revolution. Photos taken of total solar eclipse on 12 November. Two stand-up EVAs for 208 minutes and 129 minutes of umbilical EVA. None of the former problems with EVA arose. Undocking and tether experiments carried out. Mission successfully ended after 94 hours, 35 minutes, and 59 revolutions. Landed 4.8 km (3 sm) off target, picked up by USS Wasp in the Atlantic. Last Gemini flight. (S)

MSFN TRAINING SATELLITES

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
TTS 1	13 Dec 67 0908 EST	Delta DSV-3E (Delta-55)	TTS-A	ETR 17B	Launched as a piggyback payload attached to rear of second stage of Delta vehicle that successfully injected Pioneer 8 intc solar orbit. Timer aboard Delta second stage ejected TTS one minute after third stage ignition. 18-kg (40-lb), eight-sided (35.6 centimeters, or 14 inches/side) satellite with solar cells on external surfaces. Contained a power supply, command receiver, telemetry transmitter, passive magnetic stabilization system, and a transponder compatible with unified S-Band (USB) system. Transponder was designed to transmit and receive S-Band data characteristics of the Apollo spacecraft and its mission. During 3-month lifetime satellite afforded each shift of every Manned Space Flight Network (MSFC) station ample opportunities to check out equipment and train personnel. 483-km (300-sm) apogee; 292-km (182-sm) perigee; 33° inclination; 92-minute period. Re-entered atmosphere 28 April 1968. (S)
TETR 2	8 Nov 68 0446 EST	Delta DSV-3E (Delta-60)	TETR-B	ETR 17B	The second of three training satellites launched to test the Manned Space Flight Network, TETR-2 was injected into Earth orbit from the Delta second stage after it had placed the third stage and primary Pioneer-D spacecraft in a parking orbit. The 18-kg (40-lb) spacecraft provided an economical and dynamic medium for exercising the unified S-band systems of the MSFN. Re-entered 19 September 1979. (S)
TETR	27 Aug 69 1759 EDT	Delta DSV-3L (Delta-73)	TETR-C	ETR 17A	This was the third spacecraft in the MSFN training series. The Delta first stage hydraulics system failed before main engine cutoff, throwing the second stage into an incorrect attitude after separation. Range Safety destructed the vehicle after 483 seconds of flight. (U)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
TETR 4	29 Sep 71 0545 EDT	Delta DSV-3L (Delta-85)	TETR-D	ETR 17A	Carried as a secondary payload on the primary OSO 7 mission, the 20-kg (44-lb) octahedron was ejected from the second stage of the Delta-85 launch vehicle after that stage had separated from the OSO-H spacecraft. Its S-band transponder provided an active target for premission checkout of the Manned Space Flight Network tracking stations, training of MSFN system personnel, routine mission simulations, and development and verification of acquisition and handover techniques. Re-entered 21 September 1978. (S)

SUBORBITAL

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo-Saturn	26 Feb 66 1112 EST	Saturn IB (AS-201)	AS-201 CSM-009	ETR 34	First launch of two stage Saturn IB (AS-201) and Apollo spacecraft (009). Unmanned suborbital flight to qualify launch vehicle, spacecraft command module (CM) heat-shielding and service module (SM) systems. Liftoff was normal and powered flight was as programmed. After separation from the launch vehicle, spacecraft reached 499-km (310-sm) altitude. During descent, SM reaction-control system rockets were fired once and main engine was fired twice, to increase spacecraft's re-entry speed. SM was jettisoned and CM re-entered atmosphere at 8,382 meters per second (27,500 feet per second), reaching a re-entry heat of about 2,204°C (4,000°F). CM was recovered in good condition from South Atlantic near Ascension Island, by helicopter from USS Boxer, after 39-minute flight. (S)

NOTE

Although the AS-201 and AS-202 flights had been unofficially called the Apollo 1 and 2 missions, they had never been so designated. On 24 April 1967, Dr. George E. Mueller, Associate Administrator for Manned Space Flight, NASA, officially designated the test in which astronauts Grissom, White, and Chaffee lost their lives as Apollo 1, and also announced that the forthcoming Saturn V flight would be called Apollo 4. There are presently no missions or flights officially designated as Apollo 2 or 3.

APOLLO (continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo-Saturn	25 Aug 66 1316 EDT	Uprated Saturn I (AS-202)	AS-202 CSM-011	ETR 34	Second flight test of major spacecraft systems and second performance check of command module (CM) heat-shielding; first use of spacecraft fuel cell power system. Liftoff was normal. Launch vehicle developed 7,116,800-newton (1,600,000-lb) thrust during first (S-IB) stage powered flight. After separation of Apollo spacecraft (011), service module (SM) engine was burned once to raise spacecraft to 1,136-km (706-sm) altitude, then was ignited and cut off three more times to test rapid restart capability. CM separated from SM and re-entered atmosphere at more than 32,026 kph (19,900 mph). Maximum re-entry temperature of CM's outer surface was calculated to be about 1482°C (2700°F); interior temperature was 21°C (70°F). CM landed in Pacific 805 km (500 sm) southwest of Wake Island after 93-minute flight, and was recovered by USS Hornet. (S)

NOTE

The Saturn IB vehicle was renamed the Uprated Saturn I on 9 June 1966. On 15 January 1968, the name was changed back to Saturn IB.

EARTH ORBITAL

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Saturn	28 May 64 1207 EST	Saturn I (SA-6)	SA-6 CSM-BP-13	ETR 37B	First major flight test in Project Apollo, with successful orbiting of first boilerplate Apollo spacecraft. The payload consisted of the boilerplate and the S-IV second stage; re-entered atmosphere and disintegrated over the western Pacific during its 50th orbit of the Earth on 1 June 1964. One mission highlight was the perfect performance of the ST-124 guidance platform, which controlled the second stage during flight. One first-stage engine shut down 24 seconds early, but deviation from the planned trajectory was corrected by the SA-6 guidance system. Test considered highly successful. (S)
Saturn	18 Sep 64 1122 EST	Saturn I (SA-7)	SA-7 CSM-BP-15	ETR 37B	First demonstration of Launch Escape System (LES) design, by successful jettison during powered flight. Boilerplate Apollo spacecraft command and service modules, instrument unit and S-IV stage, were placed in orbit. All major test objectives were met. Motion picture cameras and a TV camera mounted on the S-I stage recorded flight events. However, the motion pictures were ejected near a hurricane area and recovery was not attempted. Re-entered atmosphere on 22 September 1964. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Pegasus 1	16 Feb 65 0937 EST	Saturn I (SA-9)	SA-9 CSM-BP-16	ETR 37B	Spacecraft used to detect micrometeoroids, the first primary use of capacitor-type penetration detector. Carried into orbit inside SM half of boilerplate CSM. Sensor area 185 square meters (2,000 square feet). Re-entered 17 September 1978. (S)
Pegasus 2	25 May 65 0235 EST	Saturn I (SA-8)	SA-8 CSM-BP-26	ETR 37B	Spacecraft used to obtain data on micrometeoroids in near-Earth environment. Carried into orbit inside SM half of boilerplate CSM. Test of Saturn launch vehicle. Ninth successful test in nine flights for Saturn I. Re-entered 3 November 1979. (S)
Pegasus 3	30 Jul 65 0800 EST	Saturn I (SA-10)	SA-10 CSM-BP-9A	ETR 37B	Last of current Pegasus program. Carried into orbit inside SM half of boilerplate CSM. Continued study of distribution, size, and velocity of meteoroids in near-Earth orbit, and continued development of Saturn I vehicle. Re-entered Earth atmosphere 4 August 1969. (S)

NOTE

Following a review of the results of prior suborbital and Earth-orbital missions, the Saturn IB launch vehicle and the Apollo spacecraft (command and service modules) were deemed qualified for Earth-orbital manned missions. Preparations began for the first manned Apollo flight. On 27 January 1967, at 1831 EST, fire broke out in the command module during a pre-launch test on Launch Complex 34. The crew was on board and the spacecraft's 100% oxygen atmosphere pressurized to 16.7 psia. The fire resulted in the deaths of astronauts Virgil I. (Gus) Grissom; Edward H. White, II; and Roger B. Chaffee.

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 4	9 Nov 67 0700 EST	Saturn V (AS-501)	AS-501 CSM-017	KSC LC-39 Pad A	First launch from Saturn V facilities (LC-39) at Kennedy Space Center. First launch of Saturn V vehicle. First "all-up" test of a launch vehicle (in which all stages were live and were fired on a maiden flight). All 3 stages of the Saturn V successfully fired, injecting the 3rd (S-IVB) stage and Apollo spacecraft into a 185-km (115-sm) parking orbit. After 2 revolutions, the S-IVB stage was reignited, injecting the stage and spacecraft into an Earth-intersecting orbit with an apogee of 17,213 km (10,696 sm). Following stage/spacecraft separation, the spacecraft service propulsion system (SPS) was ignited for a short-duration burn, raising the Apollo command and service (CSM) to a 18,076-km (11,232-sm) apogee. The SPS was later fired to increase the spacecraft's return speed to simulate the most severe combination of entry conditions of a lunar return trajectory. CM landing occurred in the Pacific within 16 km (10 sm) of the planned point, 8 hours, 37 minutes after liftoff. The CM, apex cover, and one of the 3 main parachutes were recovered. All primary mission objectives were successfully accomplished. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 5	22 Jan 68 1748 EST	Saturn IB (AS-204)	AS-204 LM-1	ETR 37B	First Earth-orbital test (unmanned) of Apollo spacecraft Lunar Module (LM). (On this flight Apollo Command and Service Modules were replaced by a dummy nosecone.) Launched after extended holds caused by spacecraft equipment and ground instrumentation problems, the LM and second (S-IVB) stage of Saturn IB were successfully injected into desired orbit, then separated. Although LM descent stage propulsion system did not sustain combustion following first ignition, later attempts were successful (including restart). LM ascent stage propulsion system operation and staging of ascent and descent stages were also performed successfully. All mission objectives were achieved. S-IVB stage re-entered Earth's atmosphere on 23 January, LM ascent stage re-entered on 24 January, and descent stage re-entered on 12 February 1968. No attempts at recovery were planned, or made. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 6	4 Apr 68 0700 EST	Saturn V (AS-502)	AS-502 CSM-020	KSC LC-39 Pad A	This flight was planned as a mission similar to Apollo 4 (9 November 1967), but in-flight problems prevented achievement of primary mission objectives. Liftoff was normal and on schedule. However, severe up-and-down ("pogo") vibrations of the entire space vehicle during first (S-IC) stage thrust, early shutdown of two second (S-II) stage engines, and failure of the third (S-IVB) stage engine to restart following orbital coast, required that Mission Control perform an alternate mission. Spacecraft separation was commanded, and the Service Module (SM) engine was started and burned for 445 seconds, to raise spacecraft apogee to 19,312 km (12,000 sm). This utilized most of the propellants and resulted in a Command Module (CM) re-entry of 1,919 meters per second (4,000 feet per second) less than planned. CM was recovered in Pacific near Hawaii, about 370 km (230 sm) from the target area, 9 hours, 58 minutes after liftoff. (U)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 7	11 Oct 68 1103 EST	Saturn IB (AS-205)	AS-205 CSM-101	ETR 34	Liftoff was two minutes, 45 seconds later than planned, due to a brief hold to check second stage engine chilldown. The second (S-IVB) stage, IU, SLA,and CSM were injected into Earth orbit. After a brief coast period the S-IVB stage was re-started, placing the attached spacecraft into a higher orbit. Later the CSM was separated and performed rendezvous and station-keeping maneu-vers, approaching within 21 meters (70 feet) of the spent S-IVB. Extensive checkout of spacecraft systems was performed during the course of the mission. A total of eight service propulsion system (SPS) firings were accomplished, and sev-eral changes in orbital path were made. The final SPS burn was a deorbit retrofire. The command module separated from the service module prior to re-entry, landing in the Atlantic about 11 km (7 sm) from the target point at 0711 EST on 22 October, after a flight of 260 hours, 9 minutes (10.8 days). Seven television transmissions from the spacecraft were broadcast live over commercial television, both in the U.S. and abroad. While in orbit all three astronauts developed colds, without any apparent aftereffects. (S)

Apollo 7 Astronauts

Walter M. Schirra, Jr., Commander; Donn F. Eisele, CSM Pilot; Walter Cunningham, LM Pilot

Apollo 7 Weights

Weight in Earth orbit--S-IVB stage, Instrument Unit, Spacecraft Lunar Module Adapter (SLA), and CSM--30,323 kg (66,850 lb)

Apollo 7 Firsts

First manned Apollo flight; manned Saturn IB flight; manned launch from Launch Complex 34; CSM operated by astronauts in flight; CSM performed rendezvous and station-keeping maneuvers; exten-sive checkout of CSM systems performed during mis-sion; eight Service Propulsion System firings performed; television broadcasts by astronauts in CM; and manned CM landing in ocean.

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 9	3 Mar 69 1100 EST	Saturn V (AS-504)	AS-504 CSM-104 (Gumdrop) LM-3 (Spider)	KSC LC-39 Pad A	After a three-day delay due to a minor viral infection of all three crewmen, the AS-504 vehicle was launched on time and without unplanned holds. The S-IVB stage and spacecraft were inserted into a low-Earth orbit. The spacecraft separated from the vehicle, turned around, docked to the LM, and removed it from the SLA. The S-IVB was then reignited and placed in an Earth-escape trajectory, but propellant dumps could not be performed. The CSM SPS rocket was fired four times with the LM and CSM docked. The LM descent engine was fired with the two vehicles still docked. The SPS engine was fired again. The Commander and LM pilot undocked the LM from the CSM and manuevered away from and back to the CSM, using both the descent and ascent engines. The LM flew independently of the CSM for over six hours. After redocking the crewmen returned to the CSM and the ascent stage was jettisoned; its engine was fired by remote control to send the stage into a high elliptical orbit. The SPS engine was fired twice more for maneuvers, a multispectral photography experiment was conducted, and the SPS engine fired a final time for re-entry. The USS Guadalcanal had the crew aboard one hour after splashdown on 13 March, completing a flight of 241 hours, 1 minute (10 days, 1 hour, 1 minute). LM descent stage re-entered 22 March; ascent stage still in orbit. (S)

Apollo 9 Astronauts

James A. McDivitt, Commander; David R. Scott, CSM Pilot; Russell L. Schweickart, LM Pilot

Apollo 9 Weights

Total weight--space vehicle on pad--2,893,618 kg (6,379,335 lb)
Weight in Earth orbit (S-IVB stage, IU, CSM, and LM)--131,528 kg (289,970 lb)

Apollo 9 Firsts

First launch of complete Apollo configuration (Saturn V vehicle, CSM, and LM); docking in space of CSM and LM; firing of LM ascent and descent engines in space; transfer by U.S. astronaut from one space vehicle to another; separation, rendezvous, and redocking of two spacecraft; 57 hours and 47 minutes of flight with docked spacecraft; and first EVA by an astronaut completely free of spaceship life support equipment.

LUNAR ORBITAL

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 8	21 Dec 68 0741 EST	Saturn V (AS-503)	AS-503 CSM-103 LTA-B	KSC LC-39 Pad A	The S-IVB third stage and spacecraft were launched into a low-Earth parking orbit, to check spacecraft and ground systems. During second orbit the S-IVB stage engine was reignited, boosting the space vehicle to an initial trans-lunar coast velocity of 39,579 kph (24,593 mph). The spacecraft and the S-IVB then separated, and the S-IVB was sent on a path away from the spacecraft and into solar orbit. The spacecraft's lunar trajectory required only minor midcourse corrections. Apollo 8 passed ahead of the Moon at an altitude of about 114 km (71 sm) and a speed of about 9,205 kph (5,720 mph), and at 0459 24 Dec, while on the far side, the spacecraft's engine was fired to insert it into lunar orbit. During 10 lunar revolutions the astronauts took star sightings to pinpoint landmarks, surveyed landing sites, took both still and motion pictures, and made two television transmissions to Earth. At 0110 25 Dec, again on the far side of the Moon, the spacecraft's engine was ignited to accelerate it out of lunar orbit. Initial transearth coast velocity was about 9,712 kph (6,035 mph), and only one midcourse correction was needed. At about 16,668 km (10,357 sm) from Earth the command and service modules separated, and fifteen minutes later the command module reentered Earth's atmosphere at a speed of 36,015 kph (24,243 mph). On 27 Dec, Apollo 8 landed in the Pacific 508 meters (5,000 yards) from the recovery ship USS Essex, after a flight of 147 hours. (S)

Apollo 8 Astronauts

Frank Borman, Commander; James A. Lovell, Jr., CSM Pilot; William A. Anders, LM Pilot

Apollo 8 Weights

Total weight--space vehicle on pad--2,821,236 kg (6,219,760 lb)
Weight in Earth orbit--spacecraft, IU, S-IVB--127,913 kg (282,000 lb)
Weight following translunar injection--28,871 kg (63,650 lb)

Apollo 8 Firsts

World's first manned flight to Moon; first manned flight to orbit the Moon; first manned flight to escape the influence of Earth's gravity; fastest and furthest humans travelled in space to that date; first audio-video communication by astronauts from lunar distance (6 TV transmissions: 2 enroute, 2 in lunar orbit, 2 during return); first manned Saturn V flight; first manned launch from Launch Complex 39, KSC; first manned spacecraft landing in darkness.

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 10	18 May 69 1249 EDT	Saturn V (AS-505)	AS-505 CSM-106 (Charlie Brown) LM-4 (Snoopy)	KSC LC-39 Pad B	AS-505 was the fifth successive on-time launch of the Saturn V vehicle. All three stages performed normally. The S-IVB stage was reignited in orbit and placed itself and spacecraft in a lunar trajectory. The CSM separated, turned, and docked to the LM; this docking was shown live on commercial television. The S-IVB propellants were dumped and the stage reached Earth-escape velocity. Only one spacecraft trajectory firing was utilized. At the Moon the spacecraft fired its engine twice to enter a low-circular orbit. The lunar surface was shown to Earth in a 29-minute color TV transmission. The Commander and LM Pilot undocked the LM and flew within 15.6 km (9.7 sm) of the lunar surface. When the LM descent stage was jettisioned, an incorrectly placed switch caused the ascent stage to change attitude, requiring the Commander to assume manual control. Rendezvous with the CSM was then accomplished. After jettisoning the LM ascent stage the CSM fired its engine to return to Earth. On the trip home the crew made six more TV broadcasts. Splashdown 26 May occurred in mid-Pacific, with the crew picked up shortly afterwards. The flight lasted 192 hours, 3 minutes (8 days, 3 minutes). (S)

Apollo 10 Astronauts

Thomas P. Stafford, Commander; John W. Young, CSM Pilot; Eugene A. Cernan, LM Pilot

Apollo 10 Firsts

Demonstrated rendezvous in lunar orbit, including burning LM descent stage engine in the lunar landing mission configuration and environment; evaluated LM steerable antenna at lunar distances; flew LM within 15,240 meters (50,000 feet) of lunar surface; evaluation of LM omniantennas at lunar distances; in-flight test of the abort guidance system, in-flight use of VHF ranging; landing radar test in near-lunar environment; demonstration of Westinghouse color TV camera in flight; manned navigational, visual, and photographic evaluations; largest payload placed in Earth and lunar orbit at time.

LUNAR LANDING

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 11	16 Jul 69 0932 EDT	Saturn V (AS-506)	AS-506 CSM-107 (Columbia) LM-5 (Eagle)	KSC LC-39 Pad A	Apollo 11 had the historic mission of landing a human on the Moon. Liftoff and insertion into Earth orbit were normal. The S-IVB stage was re-ignited and inserted itself and spacecraft into a lunar trajectory. The CSM then docked to the LM. Only one of the four planned trajectory correction firings was utilized. At 55 flight hours the crew transmitted TV for 96 minutes, showing themselves "live" on commercial TV. Two burns of the CSM engine placed them in a low-lunar orbit. The LM undocked and dropped toward the lunar surface. The area where the automatic systems would have landed the LM was too rocky, and the Commander took manual control and landed the craft, at 1617:43 EDT on 20 July. The two men donned spacesuits and went EVA 6-1/2 hours later, Commander Armstrong being the first man to set foot on the Moon at 2255:15 EDT. He deployed a TV camera on the way down the ladder, and the event was seen "live" by an estimated half-billion people on Earth. The two men set up a flag and scientific experiments, gathered rock samples, talked to President Nixon "live," and many other firsts. They then re-entered the LM, lifted off, rendezvoused with the CSM, and returned safely to Earth 24 July after a flight lasting 195 hours, 18 minutes (8 days, 3 hours, 18 minutes). Rock samples were turned over to scientists for analysis, which continues. (S)

Apollo 11 Astronauts

Neil A. Armstrong, Commander; Michael Collins, CSM Pilot; Edwin E. Aldrin, Jr., LM Pilot

Apollo 11 Firsts

First manned lunar landing and return; lunar surface EVA; seismometer deployed on Moon; laser reflector deployed on Moon; solar wind experiment deployed on Moon; lunar soil and rock samples returned to Earth; largest payload placed in lunar orbit at time; first test of landing radar and other landing systems on the LM under operational conditions; use of mobile quarantine facility and Lunar Receiving Laboratory at MSC.

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 12	14 Nov 69 1122 EST	Saturn V (AS-507)	AS-507 CSM-108 (Yankee Clipper) LM-6 (Intrepid)	KSC LC-39 Pad A	Apollo 12 was the second lunar landing mission. Liftoff was normal, but while passing through a low cloud the vehicle apparently caused an electrical discharge through the Saturn to the ground. Safety devices turned off most power supplies in the CSM, but the astronauts restored them and the flight continued. After a check of all systems while in Earth orbit the S-IVB stage was reignited and injected itself and spacecraft into a lunar trajectory. The CSM then docked with the LM. The LM was entered and checked to be certain the electrical discharge had not affected its systems. The CSM engine was fired twice to achieve the correct lunar orbit, and the LM separated and descended to the surface. The landing was at 0154:35 EST on 19 Nov, within 183 meters (600 feet) of the Surveyor 3 spacecraft. The crew went EVA and set up the scientific experiments and color TV camera but direct sunlight entered the lens and it became inoperative. During a second EVA the astronauts walked more than a mile. They also collected samples and parts off Surveyor 3. After a time of 31 hours, 31 minutes on the lunar surface the LM ascent stage lifted off and rendezvoused with the CSM. It fired its engine to return to Earth in the established manner, landing in the mid-Pacific 24 Nov after a flight of 244 hours, 36 minutes (10 days, 4 hours, 36 minutes). The samples were distributed to the scientific community. (S)

Apollo 12 Astronauts

Charles Conrad, Jr., Commander; Richard F. Gordon, Jr., CSM Pilot; Alan L. Bean, LM Pilot

Apollo 12 Firsts

First use of S-IVB stage to perform an evasive maneuver; use of a hybrid trajectory; largest payload placed in lunar orbit to that date; demonstration of a point landing capability; use of two lunar surface EVA periods; first Apollo Lunar Surface Experiments Package (ALSEP) deployed on the Moon; deployment of the erectable S-Band antenna; use of geologist to plan lunar surface traverse in real time; documentation of samples as they were taken on the Moon; double-core tube sample taken; return of spacecraft parts (Surveyor 3) that had been on Moon 2-1/2 years; longest distance traveled on lunar surface, and largest payload returned from lunar surface, to date; first multispectral terrain photography from lunar orbit.

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 13	11 Apr 70 1413 EST	Saturn V (AS-508)	AS-508 CSM-109 (Odyssey) LM-7 (Aquarius)	KSC LC-39 Pad A	Apollo 13 was planned as the third lunar landing mission. First stage performance was nominal, but the S-II second stage center engine cut off 132 seconds early. The remaining four engines burned an extra 34 seconds, and the S-IVB nine seconds, to compensate. Lunar trajectory insertion occurred on schedule. The CSM then turned and docked with the LM. The spent S-IVB stage was fired to guide it to an impact point on the Moon 15 April, 137 km (85 sm) from the seismometer established by Apollo 12. The CSM flight was normal until almost 56 hours after liftoff, at which point a fire occurred in the No. 2 oxygen tank in the SM. This led to loss of all fuel cell power as well as other CSM failures. The mission was aborted and the task of getting the astronauts safely home began. The CSM was powered down and the astronauts entered the LM. The LM descent engine was fired twice to establish a faster return path after circling the Moon, and twice for trajectory correction. The SM and then the LM were jettisoned as the astronauts neared Earth, and re-entry occurred in the usual manner in the CSM, powered by its batteries. The astronauts were recovered from the mid-Pacific within an hour after landing 17 April, after a flight of 142 hours, 54 minutes (5 days, 22 hours, 5 minutes). (P)

Apollo 13 Astronauts

James A. Lovell, Jr., Commander; John L. Swigert, Jr., CSM Pilot; Fred W. Haise, Jr., LM Pilot

Apollo 13 Firsts

First use of LM as "lifeboat" when CSM was powered down; operational firing of LM descent engine in lunar environment to change velocity of CSM/LM while docked; attitude positioning of CSM/LM with LM guidance systems; demonstrated feasibility of conserving consumables by powering down CSM; operational problem-solving on real-time basis by both astronauts and ground-support personnel; and safe recovery of astronauts from disabled CSM.

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 14	31 Jan 71 1603 EST	Saturn V (AS-509)	AS-509 CSM-110 (Kitty Hawk) LM-8 (Antares)	KSC LC-39 Pad A	Spacecraft modifications to improve mission scientific capabilities, plus changes in flight plan and flight hardware for greater safety margins (as result of Apollo 13 problems), caused launch date to be moved from Oct to Nov 70; then to 31 Jan 71 (13th anniversary of Explorer 1). Countdown was normal until T-8 minutes, when weather restrictions (imposed after Apollo 12) caused an unplanned 40-minute hold. Delayed liftoff necessitated revised launch-to-orbit azimuth and a modified translunar trajectory so spacecraft would reach Moon on schedule. CSM-LM docking, following translunar injection, achieved on sixth try. Spacecraft entered initial lunar orbit on 4 Feb. Orbital path later lowered to minimum of 15,240 m (50,000 ft) to permit a shorter, steeper LM descent path. "Antares" landed on Moon at 0418 EST 5 Feb, 27 m (87 ft) from target point in Fra Mauro highlands. During two excursions on lunar surface (totaling 9 hrs, 24 mins) Shepard and Mitchell covered 3.3 km (2 sm), while Roosa conducted scientific experiments from CSM in lunar orbit. Lunar liftoff occurred 5 Feb after 33-hr, 32-min stay; rendezvous, docking, and transfer were normally achieved. "Kitty Hawk" departed lunar orbit after 34.5 revolutions. CM landed in mid-Pacific at 1605 EST 9 Feb within 1.6 kilometers (one mile) of planned landing point, completing 9-day, 2-minute mission. (S)

Apollo 14 Astronauts

Alan B. Shepard, Commander; Stuart A. Roosa, CSM Pilot; Edgar D. Mitchell, LM Pilot

Apollo 14 Achievements

Third manned lunar landing mission and return. First use of mobile equipment transporter (a small, two-wheeled handcart) on lunar surface. Lunar surface stay time, distance traversed on lunar surface, and payload returned from lunar surface were considerably greater than previous missions. First use of shortened descent and rendezvous technique. First extensive orbital science period conducted during CSM solo operations.

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 15	26 Jul 71 0934 EDT	Saturn V (AS-510)	AS-510 CSM-112 (Endeavour) LM-10 (Falcon) LRV-1	KSC LC-39 Pad A	Prelaunch checkout and final countdown moved steadily to an on-time liftoff for the first of the Apollo missions with lengthened stay-time and improved mobility for extensive lunar surface operations. Spacecraft entered initial lunar orbit on 29 February. Despite 25-minute delay in CSM-LM undocking, "Falcon" landed on Moon at 1816 EDT 30 July. Shortly after touchdown Scott stood in LM upper hatch to observe and photograph landing area. Lunar surface activity began the following morning. Although some minor difficulty was experienced with deployment of the lunar roving vehicle, and with its steering mechanism, it later functioned perfectly. While Scott and Irwin explored the edge of the Hadley Rille and the base of the lunar Apennines, Worden conducted experiments from lunar orbit. LM lifted off 66 hours, 55 minutes after touchdown. Following crew and cargo transfer to CSM, subsatellite was injected into 141 x 101-km (87 x 62-sm) lunar orbit. "Endeavour" departed Moon after 74 revolutions and landed in mid-Pacific, completing 12-day, 7-hour, 12-minute mission. (S)

Apollo 15 Astronauts

David R. Scott, Commander; Alfred M. Worden, CSM Pilot; James B. Irwin, LM Pilot

Apollo 15 Achievements

Fourth manned lunar landing and return; first extended lunar exploration mission. First lunar orbital science payload carried in Service Module bay and operated by CSM Pilot. First use of manned lunar roving vehicle (traveled 27.9 km--17.25 sm--over lunar surface). First ground-controlled remote operation of TV camera on the Moon (observed LM lunar liftoff). First subsatellite launched from CSM in lunar orbit. First spacewalk from CM during return flight to Earth.

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 16	16 Apr 72 1254 EST	Saturn V (AS-511)	AS-511 CSM-113 (Casper) LM-11 (Orion) LRV-2	KSC LC-39 Pad A	Mission events proceeded routinely from prelaunch countdown through CSM/LM undocking prior to LM descent to the lunar surface. Shortly after undocking, however, an apparent problem in the thrust vector controls of the service module propulsion system required that the CSM and LM keep station for 5 hrs, 43 mins, until a decision was made to continue the mission. "Orion" landed at 2124 20 April in the Descartes area, within 230 meters (755 feet) of the planned point. During three trips totalling 20 hrs, 15 mins, astronauts Young and Duke covered 27.1 km (16.8 sm) over the lunar highland surface and spent 9 hrs, 7 mins on foot performing scientific duties and collecting 96.6 kg (213 lb) of lunar samples. While Young and Duke were exploring the Moon, Mattingly was conducting lunar science experiments from lunar orbit. Lunar liftoff occurred after 71 hrs, 2 mins of stay time; rendezvous and docking were normal. Subsatellite was ejected into lunar orbit and "Casper" began its return to Earth after completing 64 revolutions of the Moon. Command module landed in mid-Pacific, completing 265-hr, 51-min mission. (S)

Apollo 16 Astronauts

John W. Young, Commander; Thomas K. Mattingly, II, CSM Pilot; Charles M. Duke, Jr., LM Pilot

Apollo 16 Achievements

Fifth successful manned lunar landing and return, first landing in and exploration of lunar highlands; largest payload placed in lunar orbit to date (34,519 kg--76,100 lb).

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 17	7 Dec 72 0033 EST	Saturn V (AS-512)	AS-512 CMS-114 (America) LM-12 (Challenger) LRV-3	KSC LC-39 Pad A	Launch countdown proceeded smoothly until the final minutes when the automatic Terminal Countdown Sequencer failed to command pressurization of the Saturn V second-stage LOX tank. Although tank pressurization was commanded manually, the failed function prevented actuation of an interlock in the ready-to-launch logic train and the sequencer commanded an automatic shutdown. It was determined that the interlock could be bypassed by a jumper. The work-around was analyzed and checked out on a breadboard sequencer at MSFC, and the decision made to proceed with the countdown. The final Apollo mission lifted off 2 hrs, 40 mins late. Flight to the Moon was near-routine, and "Challenger" landed at Taurus-Littrow at 1455 EST 11 Dec. During three traverses with the LRV on the lunar surface, astronauts Cernan and Schmitt stopped at numerous pre-planned points to conduct geological observations and collect samples, while astronaut Evans operated scientific equipment in the CSM "America" in lunar orbit. Lunar liftoff occurred at 1745 EST, 14 Dec. After 75 revolutions about the Moon, "America" departed for Earth. During the return flight, astronaut Evans exited the spacecraft to retrieve film from cameras located in the service module. On 19 Dec the command module landed in the mid-Pacific 12 days, 14 hrs after liftoff, bringing the Apollo manned lunar landings to a close. (S)

Apollo 17 Astronauts

Eugene A. Cernan, Commander; Ronald E. Evans, CSM Pilot; Harrison H. Schmitt, LM Pilot

Apollo 17 Achievements

Sixth successful manned lunar landing and return (last in Apollo Program); first geologist astronaut (Schmitt) on lunar surface; longest lunar surface stay time (74 hrs, 59 mins, 38 secs); longest single lunar surface excursion (7 hrs, 37 mins, 22 secs); longest total lunar surface excursion (22 hrs, 5 mins, 4 secs); longest lunar distance travelled by LRV on one traverse (19 km--11.8 sm); longest total distance traversed with LRV (35 km--21.75 sm); most lunar samples returned to Earth (115 kg--250 lb); longest time in lunar orbit (147 hrs, 48 mins--75 hrs).

SKYLAB

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Skylab 1	14 May 73 1330 EDT	Saturn V (AS-513)	SL-1 AS-513 OWS AM-MDA ATM	KSC LC-39 Pad A	Prelaunch countdown was completed with no unscheduled holds, despite problems within the ML computer during the final two hours. The unmanned Orbital Workshop (OWS) was inserted into the desired orbit of 440 x 424 km (273 x 263 sm) with an inclination of 50° and a period of 93 minutes. The payload shroud was jettisoned and the Apollo Telescope Mount (ATM) and its solar arrays deployed normally. However, inspection and analysis of telemetry records verified that about 63 seconds after liftoff the OWS meteoroid shield (which also provided protection from solar heating) had prematurely deployed and was torn off, taking one of the OWS solar array wings with it. A piece of the shroud had wrapped around the other solar array wing, keeping it from deploying and generating electrical power. Temperatures inside the OWS rose to 52°C (125°F). The manned SL-2 mission was postponed while solutions to the OWS heat and power loss problems were devised, equipment constructed, and the crew trained in its installation. Three thermal shields were prepared for possible use: The Skylab Parasol that could be deployed through the OWS scientific airlock; a "twin-pole" shield that could be deployed by the crew working outside the OWS; and a "sail" that could be deployed by crew members standing in the open hatch of the SL-2 CSM. Meanwhile, ground controllers combatted critical internal temperatures by changing the attitude of the OWS in relation to the Sun by varying the systems configuration, while three complete purging/repressurization cycles were performed to eliminate any toxic gases emanating from materials within the OWS due to the high temperatures. (S)

Skylab 1 Achievements

Largest habitable structure ever placed in orbit, with 360 cubic meters (12,700 cubic feet) of work and living space. Skylab was 35.7 meters (117 feet) long, 27.4 meters (90 feet) wide across its solar panels, and had a mass of 90,605 kg (199,750 lb) with the CSM attached. The ATM performed the most thorough manned program of observation of solar flares to date, obtaining some of the best coverage available. More men (nine) lived in Skylab than in any other space vehicle. The program returned a wealth of scientific and physiological data. Three crews traveled a total of 113.5 million-km (70.5 million-sm), lived in space for 171.5 days, and completed 2,476 manned orbits of the Earth. Skylab returned harmlessly to Earth on 11 July 1979, after completing 34,181 orbits.

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Skylab 2	25 May 73 0900 EDT	Saturn IB (AS-206)	SL-2 AS-206 CSM-116	KSC LC-39 Pad B	Due to the OWS problems, launch of SL-2 was postponed from 15 May to 20 May; then to 25 May. On the evening of 24 May, lightning struck the Mobile Service Structure surrounding the space vehicle, but tests showed no damage. The countdown began on time and progressed to lift-off with no unscheduled holds. Stowage of the three thermal shields and their associated tools in the CM was performed during the countdown. Rendezvous of the CSM with the OWS was accomplished on the fifth orbit. Prior to docking a flyaround of the OWS verified that one solar array wing was missing and the second was only partially deployed. An attempt to dislodge the debris restraining the wing while standing in the open CM hatch was unsuccessful. Docking of the CSM with the Multiple Docking Adapter (MDA) was completed on the fifth attempt. On Mission Day 2 (MD-2) the crew entered the OWS and deployed the parasol thermal shield through the scientific airlock. Temperatures immediately began dropping. On MD-3 the crew started activating the OWS. Experiments began on MD-5 and continued through MD-25. On MD-14 astronauts Conrad and Kerwin opened the Airlock Module hatch and, standing on the outside of the OWS, succeeded in dislodging the debris and extending the wing, restoring electrical power to the OWS. On the 28th day, the crew re-entered the CM, undocked, and returned to Earth, landing in the Pacific southwest of California. Based on their success in overcoming the OWS problems and general mission performance, the SL-1/SL-2 missions were designated as successful. (S)

Skylab 2 Astronauts

Charles Conrad, Jr., Commander
Joseph P. Kerwin, Science Pilot
Paul J. Weitz, Pilot

Skylab 2 Achievements

First three-man crew to stay in space for 28 days. First major repairs to an orbiting space station, proving that men can accomplish more than programmed machines in space. First occupancy of a U.S. space station, and operation of its scientific instruments and life support systems (including obtaining extensive physiological measurement data).

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Skylab 3	28 Jul 73 0711 EDT	Saturn IB (AS-207)	SL-3 AS-207 CSM-117	KSC LC-39 Pad B	Prelaunch checkout and countdown proceeded normally to an on-time liftoff. Shortly after docking and entering the OWS all three crew members experienced motion sickness, causing a delay in activating the OWS equipment. On 2 Aug apparent failure of two of four thruster quadrants of the service module reaction control system raised the possibility of an early end to the mission, or of inability of CSM to safely deorbit. KSC launch crews were placed on a 24-hour seven-day-week schedule to ready SL-4 space vehicle for rescue, but a decision was made to continue the mission. Working outside Workshop, astronauts extended "twin-pole" thermal shield to replace "parasol" deployed by SL-2 crew. Skylab 3 crew then continued extensive series of experiments, particularly of unanticipated solar activity, and mission was extended to 59 days to make up time lost earlier. Although SL-4 vehicle had been brought to launch readiness if needed, CSM-117 systems functioned during deorbit maneuvers and command module landed in Pacific Ocean off southern California. (S)

Skylab 3 Astronauts

Alan L. Bean, Commander
Owen K. Garriott, Science Pilot
Jack R. Lousma, Pilot

Skylab 3 Achievements

Established new record for manned space flight, more than double the 28 days of Skylab 2 crew. Proved that signs of physical deterioration experienced by first Skylab crew reversed themselves over a longer period, except for bone calcium loss. Astronauts obtained excellent scientific results using ATM, EREP, and other instruments. Proved long-term viability of both space station and astronauts.

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Skylab 4	16 Nov 73 0901 EST	Saturn IB (AS-208)	SL-4 AS-208 (SM-119)	KSC LC-39 Pad B	The SL-4 checkout revealed hairline cracks on the tailfins of the S-IB rocket. They were changed out on the pad, delaying the launch by several days. Some other internal cracks were ruled not serious. Food bars were added to the food supply to permit a long mission if advisable. The actual launch operation went smoothly, and rendezvous occurred on time. Some replacement parts were installed in Skylab, then the crew settled down to establish a manned space flight record for the U.S. and at that time for the world. The astronauts were given so much work to do by ground controllers they had little time to rest, and at first made mistakes. When the workpace was slowed their efficiency improved, and in the end they did even more work than was programmed. They traveled 55.5 million-km (34.5 million-sm), during a mission lasting 84 days, one hour, and 16 minutes. This crew achieved one of the most desired scientific objectives, full photographic coverage of a solar flare from its beginning to its full size. They also studied the comet Kohoutek from above the atmosphere for 156 hours, obtaining the best record of its type to date. They performed scientific experiments for 1,563.2 hours, more than the first two crews combined. The astronauts were also in better physical condition afterward, except for bone calcium loss, indicating long duration flights are practical. This flight set many records for the U.S. which will probably last for years to come. (S)

Skylab 4 Astronauts

Gerald P. Carr, Commander
Edward D. Gibson, Science Pilot
William R. Pogue, Pilot

Skylab 4 Achievements

Proved man can survive and function indefinitely in space, if the bone calcium loss problem can be solved. Established the value of long-term manned scientific instruments operating above the atmosphere. Paved the way for permanent manned space stations in orbit around the Earth, or other long-duration space missions.

APOLLO-SOYUZ TEST PROJECT

ASTP

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo-Soyuz Test Project	15 July 75 1550 EDT	Saturn IB (AS-210)	ASTP AS-210 CSM-111	KSC LC-39 Pad B	First international manned space flight. This five-year program was conducted to establish space rescue techniques for the U.S.A. and U.S.S.R., conduct scientific experiments, and study the feasibility of more ambitious joint programs in the future. The Soyuz lifted off first, at 0820, and entered orbit. The countdown went smoothly at KSC, and liftoff was on time. The astronauts turned the Apollo spacecraft around in space and docked with the docking module attached to the SIV-B stage. The Apollo then "chased" the Soyuz in orbit, docking with it at rendezvous July 17 at 1210 EDT. The two spacecraft remained attached, conducting joint experiments in space, sharing each other's accommodations and meals, and holding press conferences with the news media of the world, until undocking at 0812 on July 19. The spacecraft then docked again, for practice, at 0834 and separated at 1127 for the last time. Soyuz landed in Russia at 1848 EDT July 21. The Americans stayed aloft for three more days, conducting a series of experiments. They landed in the Pacific Ocean at 1718 EDT. The astronauts failed to turn on the Earth Landing System at the correct time, resulting in some gas entering the spacecraft, but the crew were not hurt. The ASTP proved that American and Russian space programs could cooperate and perform joint missions in space. All major objectives were achieved. (S)

ASTP Astronauts

Thomas P. Stafford, Commander
Donald K. Slayton, Docking Module Pilot
Vance D. Brand, Command Module Pilot

(U.S.S.R. Cosmonauts
Aleksey A. Leonov, Commander
Valeriy N. Kubasov, Flight Engineer)

ASTP Achievements

First major cooperation between only two nations engaged in manned space flight. First meeting of two manned spacecraft of different nations in space, first docking, and first visits by astronauts and cosmonauts into the others' spacecraft. Established workable joint docking mechanisms, taking first steps toward mutual rescue capability of both Russian and American manned missions in space.

APPENDIX A

SUMMARY OF LAUNCHES PRIOR TO OCTOBER 1958 IN SPACE PROJECTS LATER TRANSFERRED TO NASA

On 1 October 1958, coincidental with the official activation of the National Aeronautics and Space Administration, President Eisenhower issued Executive Order 10783. This order transferred jurisdiction to NASA, from the Department of Defense's Advanced Research Projects Agency, over several space programs that were already well under way. Included among these were: the Naval Research Laboratory's International Geophysical Year satellite program (Vanguard), initiated 9 September 1955; the Army Ballistic Missile Agency's satellite launching project (Explorer), authorized to proceed on 8 November 1957; and certain lunar probes under the direction of the Air Force Ballistic Missile Division (forerunner of the Pioneer space probes), officially announced on 27 March 1958.

This Appendix lists the launching attempts in these programs that occurred prior to 1 October 1958. Launching attempts made subsequent to 1 October 1958, as a part of these and other space programs transferred to NASA by Executive Order 10783, are contained in the main portion of this report.

SUMMARY OF LAUNCHES PRIOR TO OCTOBER 1958 IN SPACE PROJECTS LATER TRANSFERRED TO NASA
(All launches were from Cape Canaveral)

VANGUARD

Mission Name	Launch Date/Time	Launch Vehicle	Intntl. Desig.	Site/ Pad	Remarks/Results
Vanguard Test Vehicle	6 Dec 57 1145 EST	Vanguard TV-3	--	18A	The first attempt by the Naval Research Laboratory (NRL) to orbit a test satellite using a Vanguard rocket with all three stages powered was unsuccessful when a mechanical failure in the propulsion system caused it to burst into flames two seconds after it was fired, after lifting about 15 centimeters (six inches) off the pad. (Previous Vanguard project launches at Cape Canaveral were launch vehicle development tests, not orbital attempts.) (U)
Vanguard Test Vehicle (Backup)	5 Feb 58 0233 EST	Vanguard TV-3BU	--	18A	The second trial firing of a Vanguard test satellite failed as defects in the first stage engine control system caused the rocket to veer to the right and break in two about 50 seconds after launch, 4.5 km (4 sm) up. The rocket was destroyed by the range safety officer. (U)

SUMMARY OF LAUNCHES PRIOR TO OCTOBER 1958 IN SPACE PROJECTS LATER TRANSFERRED TO NASA
(All launches were from Cape Canaveral)
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	Intntl. Desig.	Site/ Pad	Remarks/Results
Vanguard 1	17 Mar 58 0725 EST	Vanguard TV-4	1958 Beta 1 (casing) 1958 Beta 2 (satellite)	18A	Vanguard 1, the second U.S. satellite, an aluminum test sphere 16.25 centimeters (6.4 inches) in diameter and weighing 1.47 kg (3.25 lb), was successfully launched into orbit, together with its 22.6-kg (50-lb) carrier rocket casing, just "two years, six months and eight days after initiation of the project from scratch," as pointed out by John P. Hagen, NRL program director. Initial perigee was 358 km (409 sm), and apogee was 3,948 km (2,453 sm), at an inclination to the equator of 34.26°. Geodetic observations of its stable orbit determined that Earth is slightly pear-shaped. Although not actually instrumented, two transmitters were carried and temperatures could be deduced from changes in their radio frequencies. Satellite transmitted data until May 1964 and is still in orbit. Current orbital parameters are: 3,917 x 666 km (2,434 x 414 sm), inclination 34.3°, period 134 minutes. (S)
Vanguard Test Vehicle	28 Apr 58 2150 EST	Vanguard TV-5	--	18A	Attempt to orbit an instrumented satellite 50.8 centimeters (20 inches) in diameter and weighing 9.75 kg (21.5 lb), using a Vanguard test vehicle. Satellite instruments were intended to record X-rays, temperatures, and meteor data. Failure of the third stage engine to ignite due to faulty wiring in the ignition circuit resulted in the launch vehicle being unable to attain orbital speed. Satellite burned up on re-entry; launch vehicle impacted 2,414 km (1,500 sm) downrange. (U)

SUMMARY OF LAUNCHES PRIOR TO OCTOBER 1958 IN SPACE PROJECTS LATER TRANSFERRED TO NASA
(All launches were from Cape Canaveral)
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	Intntl. Desig.	Site/ Pad	Remarks/Results
Vanguard Satellite Launch Vehicle	27 May 58 2246 EST	Vanguard SLV-1	--	18A	First attempt to orbit an instrumented satellite using a nontest, operational Vanguard launch vehicle. Satellite instruments included meteor detectors, solar radiation measures, and thermometers. Liftoff was normal, and all vehicle stages fired. However, improper burnout of second stage resulted in too steep climb angle and failure to achieve orbit. Reached an altitude of 3,927 km (2,440 sm) and burned up on re-entry between Antigua and Africa, 8,047 km (5,000 sm) away. Satellite radio returned some data. (U)
Vanguard Satellite Launch Vehicle	26 Jun 58 0001 EST	Vanguard SLV-2	--	18A	Second orbital attempt using a production Vanguard launch vehicle. Satellite instrumentation was the same as for 28 April attempt. Liftoff was normal, but second stage engine cut off prematurely due to low thrust chamber pressure. Launch vehicle demonstrated structural integrity when tankage withstood pressures exceeding design values. (U)

SUMMARY OF LAUNCHES PRIOR TO OCTOBER 1958 IN SPACE PROJECTS LATER TRANSFERRED TO NASA
(All launches were from Cape Canaveral)
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	Intntl. Desig.	Site/ Pad	Remarks/Results
Vanguard Satellite Launch Vehicle	26 Sep 58 1038 EST	Vanguard SLV-3	--	18A	An abortive attempt occurred on 17 September, in which the vehicle lifted about 2.5 centimeters (one inch) off the launch pedestal, then settled back into position when uneven release of ground-disconnect plugs transmitted a spurious shutdown signal to the first stage engine. Liftoff was normal on 26 Sep, and all stages of the Vanguard SLV-3 fired. However, second stage low performance, possibly due to corrosive particles partially clogging fuel tank piping, resulted in the satellite not attaining sufficient speed to maintain an orbit. Although not verified by tracking data, the satellite may have made at least one complete orbit at an altitude 426 km (265 sm) before falling into the Indian Ocean, approximately 14,806 km (9,200 sm) from the launching site. The satellite contained instruments to measure cloud cover, and carried a tape recorder to store data for a later release on command from a ground station. (U)

SUMMARY OF LAUNCHES PRIOR TO OCTOBER 1958 IN SPACE PROJECTS LATER TRANSFERRED TO NASA
(All launches were from Cape Canaveral)
(continued)

EXPLORER

Mission Name	Launch Date/Time	Launch Vehicle	Intntl. Desig.	Site/ Pad	Remarks/Results
Explorer 1	31 Jan 58 2207 EST	Juno 1 (Jupiter C) RTV-4	1958 Alpha	26A	Explorer 1, the first American satellite, was successfully launched into an orbit with an apogee of 2,531 km (1,573 sm) and a perigee of 360 km (224 sm). The satellite, 203 centimeters (80 inches) long and 15 cm (6 inches) in diameter, was an integral part of the launch vehicle's fourth stage motor case, and weighed 14 kg (30.8 lb). Its payload, weighing 8.22 kg (18.13 lb) (including two radio transmitters and their mercury batteries), was developed by Iowa State University under the direction of James A. Van Allen, and contained instruments to measure cosmic rays, micrometeor impact, and internal and external temperatures. Analysis of data returned by Explorer 1 resulted in the discovery of belts of radiation surrounding the Earth (the Van Allen belts). The satellite transmitted data until 23 May 1958, and re-entered Earth's atmosphere 31 March 1970. The Juno I launch vehicle, developed by the Army Ballistic Missile Agency with the assistance of the Jet Propulsion Laboratory, consisted of a three-stage Jupiter C Composite Re-entry Test Vehicle modified by the addition of a live, solid propellant fourth stage. (Of the six Juno Is constructed, three successfully orbited satellites.) (S)

SUMMARY OF LAUNCHES PRIOR TO OCTOBER 1958 IN SPACE PROJECTS LATER TRANSFERRED TO NASA
(All launches were from Cape Canaveral)
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	Intntl. Desig.	Site/ Pad	Remarks/Results
Explorer 2	5 Mar 58 1327 EST	Juno I (Jupiter C) RTV-5	--	26A	An attempt to orbit the Explorer 2 satellite was unsuccessful when the fourth stage of the Juno I launch vehicle failed to ignite, resulting in insufficient speed to attain orbital velocity. The satellite probably burned up on re-entering the atmosphere, before falling into the Atlantic near Trinidad, 3,058 km (1,900 sm) from the launch site. (U)
Explorer 3	26 Mar 58 1230 EST	Juno I (Jupiter C) RTV-6	1958 Gamma	5	Explorer 3, the third U.S. IGY satellite, was successfully launched into an orbit with an apogee of 2,810 km (1,746 sm) and a perigee of 195 km (121 sm). The satellite instrumentation was similar to that of Explorer 1, with the addition of a tape recorder feature. On 1 May 1958, Dr. James A. Van Allen announced that scientific findings from Explorers 1 and 3 disclosed an unexpected band of high-intensity radiation extending from 966 km (600 sm) above Earth to possibly an 12,875 km (8,000 sm) altitude. The Explorers also showed that the atmosphere at 354 km (220 sm) was denser than predicted, that satellite temperatures would not be too great for humans, and that cosmic dust was only a small hazard to space travel. Explorer 3 transmitted data until 16 June 1958 and re-entered the atmosphere 28 June 1958. (S)

SUMMARY OF LAUNCHES PRIOR TO OCTOBER 1958 IN SPACE PROJECTS LATER TRANSFERRED TO NASA
(All launches were from Cape Canaveral)
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	Intntl. Desig.	Site/ Pad	Remarks/Results
Explorer 4	26 Jul 58 1000 EST	Juno I (Jupiter C) RTV-7	1958 Epsilon	5	The fourth U.S. IGY satellite was successfully launched by a Juno I into an orbit with an apogee of 2,221 km (1,380 sm) and a perigee of 262 km (163 sm). Instrumentation was designed to measure corpuscular radiation and consisted of two Geiger-Mueller counters and two scintillator counters. Two radios, powered by mercury batteries, transmitted information simultaneously and continuously, utilizing the satellite's stainless steel skin as antennas. Explorer 4 transmitted data until 6 October 1958 and re-entered the atmosphere on 23 October 1959. (S)
Explorer 5	24 Aug 58 0017 EST	Juno I (Jupiter C) RTV-8	--	5	The fifth orbital attempt by the Army Ballistic Missile Agency, using the Juno I launch vehicle, was unsuccessful. Liftoff was normal, but after separation of the first stage, its residual fuel carried it forward to bump and deflect from course the remaining three stages. They fired normally, but failed to carry the satellite into orbit. The flight lasted 659 seconds, on a path northeast from Cape Canaveral. The satellite carried instrumentation designed to measure the Van Allen radiation belts. (U)

SUMMARY OF LAUNCHES PRIOR TO OCTOBER 1958 IN SPACE PROJECTS LATER TRANSFERRED TO NASA
(All launches were from Cape Canaveral)
(continued)

PIONEER

Mission Name	Launch Date/Time	Launch Vehicle	Intntl. Desig.	Site/ Pad	Remarks/Results
Pioneer	17 Aug 58 0718 EST	Thor-Able-1	--	17A	The first attempt by the Air Force Ballistic Missile Division to launch a lunar probe, using the three-stage Thor-Able launch vehicle, was unsuccessful due to a failure in the first-stage engine. Liftoff was normal, but an explosion ripped the vehicle apart after 77 seconds of flight, at an altitude of about 16 km (10 sm). The mission had been designed to put 18 km (40 lb) of instruments in an orbit around the Moon, to take pictures of the backside. In addition to the scanning devices, the probe contained a magnetometer, a meteoroid co[illegible]er, and thermometers. Had the mission been successful, the probe would have been given the designation of Pioneer. (U)

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1958		
THOR/ABLE-1 Pioneer 1	ETR 10-11-58	I-34
JUNO I-49 Beacon	ETR 10-22-58	I-1
THOR/ABLE-2 Pioneer 2	ETR 11-08-58	I-34
JUNO II-11 Pioneer 3	ETR 12-06-58	I-34
JUPITER-13 Bioflight 1	ETR 12-13-58	I-31
1959		
VANGUARD-4 Vanguard 2	ETR 02-17-59	I-2
JUNO II-14 Pioneer 4	ETR 03-03-59	I-34
VANGUARD-5 Vanguard	ETR 04-13-59	I-2
JUPITER-18 Bioflight 2	ETR 05-28-59	I-31
VANGUARD-6 Vanguard	ETR 06-22-59	I-2
JUNO II-16 Explorer	ETR 07-16-59	I-3
THOR/ABLE-3 Explorer 6	ETR 08-07-59	I-3
JUNO II-19B Beacon	ETR 08-14-59	I-1
ATLAS-10D Big Joe	ETR 09-09-59	V-1
VANGUARD-7 Vanguard 3	ETR 09-18-59	I-2
JUNO II-19A Explorer 7	ETR 10-13-59	I-3
ATLAS/ABLE-1 Pioneer	ETR 11-26-59	I-35
1960		
THOR/ABLE-4 Pioneer 5	ETR 03-11-60	I-36
JUNO II-19C Explorer	ETR 03-23-60	I-3
THOR/ABLE-5 TIROS 1	ETR 04-01-60	II-1
DELTA-1 Echo	ETR 05-13-60	III-1
MERCURY/ATLAS-50D MA-1	ETR 07-29-60	V-1
DELTA-2 Echo 1	ETR 08-12-60	III-1
ATLAS/ABLE-2 Pioneer	ETR 09-25-60	I-35
JUNO II-19D Explorer 8	ETR 11-03-60	I-4
MERCURY/REDSTONE-1 MR-1	ETR 11-21-60	V-1
DELTA-3 TIROS 2	ETR 11-23-60	II-1
ATLAS/ABLE-3 Pioneer	ETR 12-15-60	I-35
MERCURY/REDSTONE-3 MR-1A	ETR 12-19-60	V-1
1961		
MERCURY/REDSTONE-2 MR-2	ETR 01-31-61	V-2
JUNO II-19F Explorer	ETR 02-24-61	I-4
MERCURY/ATLAS-67D MA-2	ETR 02-21-61	V-2
MERCURY/REDSTONE-5 MR-BD	ETR 03-24-61	V-2
DELTA-4 Explorer 10	ETR 03-25-61	I-4
MERCURY/ATLAS-100D MA-3	ETR 04-25-61	V-4
JUNO II-19E Explorer 11	ETR 04-27-61	I-4
MERCURY/REDSTONE-7 MR-3	ETR 05-05-61	V-3
JUNO II-19G Explorer	ETR 05-24-61	I-4
DELTA-5 TIROS-3	ETR 07-12-61	II-1
MERCURY/REDSTONE-8 MR-4	ETR 07-21-61	V-3
DELTA-6 Explorer 12	ETR 08-15-61	I-5
ATLAS/AGENA-1 Ranger 1	ETR 08-23-61	I-42
MERCURY/ATLAS-88D MA-4	ETR 09-13-61	V-4
SATURN SA-1	ETR 10-27-61	IV-1
MERCURY/SCOUT MS-1	ETR 11-01-61	V-4
ATLAS/AGENA-2 Ranger 2	ETR 11-18-61	I-42
MERCURY/ATLAS-93D MA-5	ETR 11-29-61	V-4
1962		
AVT-1 Big Shot 1	ETR 01-15-62	III-1
ATLAS/AGENA-3 Ranger 3	ETR 01-26-62	I-42
DELTA-7 TIROS 4	ETR 02-08-62	II-1
MERCURY/ATLAS-109D MA-6	ETR 02-20-62	V-4
DELTA-8 OSO 1	ETR 03-07-62	I-15
ATLAS/AGENA-4 Ranger 4	ETR 04-23-62	I-42
SATURN SA-2	ETR 04-25-62	IV-1
DELTA-9 Ariel 1	ETR 04-26-62	I-24
CENTAUR 1	ETR 05-08-62	IV-3

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1965 (continued)		
DELTA-33 OSO-C	ETR 08-25-65	I-15
THOR/AGENA-4 OGO 2	WTR 10-14-65	I-18
ATLAS TLV-5301 Gemini 6 Target Vehicle	ETR 10-25-65	V-8
DELTA-34 Explorer 29 (GEOS 1)	ETR 11-06-65	II-21
THOR/AGENA-5 Alouette 2 & Explorer 31	WTR 11-28-65	I-7, I-25
TITAN II GLV-7 Gemini 7	ETR 12-04-65	V-8
TITAN II GLV-6 Gemini 6A	ETR 12-15-65	V-8
DELTA-35 Pioneer 6	ETR 12-16-65	I-36
1966		
DELTA-36 ESSA 1	ETR 02-03-66	II-3
SATURN IB AS-201	ETR 02-26-66	V-14
DELTA-37 ESSA 2	ETR 02-28-66	II-3
ATLAS TLV-5302 Gemini 8 Target Vehicle	ETR 03-16-66	V-8
TITAN II GLV-8 Gemini 8	ETR 03-16-66	V-9
CENTAUR-8 Surv. Mass Model	ETR 04-07-66	IV-4
ATLAS/AGENA-15 OAO 1	ETR 04-08-66	I-20
THOR/AGENA-6 Nimbus 2	WTR 05-15-66	II-12
ATLAS TLV-5303 Gemini 9 Target Vehicle	ETR 05-17-66	V-9
DELTA-38 Explorer 32	ETR 05-25-66	I-7
CENTAUR-10 Surveyor 1	ETR 05-30-66	I-45
ATLAS TLV-5304 Gemini 9A Augmented Target	ETR 06-01-66	V-9
TITAN II GLV-9 Gemini 9A	ETR 06-03-66	V-10
ATLAS/AGENA-16 OGO 3	ETR 06-06-66	I-18
THOR/AGENA-7 PAGEOS 1	WTR 06-23-66	II-21
DELTA-39 Explorer 33	ETR 07-01-66	I-7
SATURN IB SA-203	ETR 07-05-66	IV-2
ATLAS TLV-5305 Gemini 10 Target Vehicle	ETR 07-18-66	V-10
TITAN II GLV-10 Gemini 10	ETR 07-18-66	V-10
ATLAS/AGENA-17 Lun. Orb. 1	ETR 08-10-66	I-48
DELTA-40 Pioneer 7	ETR 08-17-66	I-36
ATLAS TLV-5306 Gemini 11 Target Vehicle	ETR 09-12-66	V-10
TITAN II GLV-11 Gemini 11	ETR 09-12-66	V-11
SATURN IB AS-202	ETR 08-25-66	V-15
CENTAUR-7 Surveyor 2	ETR 09-20-66	I-45
DELTA-41 ESSA 3	WTR 10-02-66	II-3
CENTAUR-9 Surv. Mass Model	ETR 10-26-66	IV-4
DELTA-42 Intelsat II F-1	ETR 10-26-66	III-12
ATLAS/AGENA-18 Lun. Orb. 2	ETR 11-06-66	I-48
ATLAS TLV-5307 Gemini 12 Target Vehicle	ETR 11-11-66	V-11
TITAN II GLV-12 Gemini 12	ETR 11-11-66	V-11
ATLAS/AGENA-19 ATS 1	ETR 12-06-66	IV-8
DELTA-43 Biosatellite 1	ETR 12-14-66	I-32
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DELTA-45 ESSA 4	WTR 01-26-67	II-4
ATLAS/AGENA-20 Lun. Orb. 3	ETR 02-04-67	I-48
DELTA-46 OSO 3	ETR 03-08-67	I-15
DELTA-47 Intelsat II F-3	ETR 03-22-67	III-12
ATLAS/AGENA-21 ATS 2	ETR 04-05-67	IV-8
CENTAUR-12 Surveyor 3	ETR 04-17-67	I-45
DELTA-48 ESSA 5	WTR 04-20-67	II-4
ATLAS/AGENA-22 Lun. Orb. 4	ETR 05-04-67	I-48
DELTA-49 Explorer 34	WTR 05-24-67	I-7
ATLAS/AGENA-23 Mariner 5	ETR 06-14-67	I-51
CENTAUR-11 Surveyor 4	ETR 07-14-67	I-45
DELTA-50 Explorer 35	ETR 07-19-67	I-8
THOR/AGENA-8 OGO 4	WTR 07-28-67	I-19
ATLAS/AGENA-24 Lun. Orb. 5	ETR 08-01-67	I-49

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DELTA-52 Intelsat II F-4	ETR 09-27-67	III-13
DELTA-53 OSO 4	ETR 10-18-67	I-15
ATLAS/AGENA-25 ATS 3	ETR 11-05-67	IV-9
CENTAUR-14 Surveyor 6	ETR 11-07-67	I-46
SATURN V AS-501 Apollo 4	ETR 11-09-67	V-18
DELTA-54 ESSA 6	WTR 11-10-67	II-4
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DELTA-56 GEOS 2	WTR 01-11-68	II-21
SATURN IB AS-204 Apollo 5	ETR 01-22-68	V-19
ATLAS/AGENA-28 OGO 5	ETR 03-04-68	I-19
SATURN V AS-502 Apollo 6	ETR 04-04-68	V-20
THOR/AGENA-9 Nimbus B	WTR 05-18-68	II-13
DELTA-57 Explorer 38	WTR 07-04-68	I-8
CENTAUR-17 ATS 4	ETR 08-10-68	IV-9
DELTA-58 ESSA 7	WTR 08-16-68	II-4
DELTA-59 Intelsat III-A	ETR 09-18-68	III-13
SATURN IB AS-205 Apollo 7	ETR 10-11-68	V-21
DELTA-60 Pioneer 9 & TETR 2	ETR 11-08-68	I-38, V-12
DELTA-61 HEOS 1	ETR 12-05-68	I-27
CENTAUR-16 OAO 2	ETR 12-07-68	I-20
DELTA-62 ESSA 8	WTR 12-15-68	II-5
DELTA-63 Intelsat III F-2	ETR 12-18-68	III-14
SATURN V AS-503 Apollo 8	ETR 12-21-68	V-23
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DELTA-65 ISIS 1	WTR 01-28-69	I-26
DELTA-66 Intelsat III F-3	ETR 02-05-69	III-14
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THOR/AGENA-10 Nimbus 3 & EGRS 13	WTR 04-13-69	II-13
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DELTA-68 Intelsat III F-4	ETR 05-21-69	III-15
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