JOHN F. KENNEDY SPACE CENTER

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A Summary of

MAJOR NASA LAUNCHINGS

Eastern Test Range
(ETR)

Western Test Range
(WTR)

October 1, 1958 - September 30, 1973

KSC Historical Services
John F. Kennedy Space Center
National Aeronautics and Space Administration
Kennedy Space Center, Florida

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FOREWORD

With the publication of this edition, "A Summary of Major NASA Launchings, Eastern Test Range and Western Test Range" now spans fifteen years in the launch history of the National Aeronautics and Space Administration, from October 1, 1958 through September 30, 1973. The initial brief summary of NASA Atlantic Missile Range (AMR) launchings 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 launchings conducted under the direction of the John F. Kennedy Space Center (or its precursors) from both the Eastern and Western Test Ranges. This edition supercedes all previous issues of this Historical Report.

The material contained in this report was compiled from several different sources. Documents consulted included: 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, for providing data not otherwise available. Mr. Francis E. Jarrett, KSC Historian, provided valuable editorial assistance.

The report is divided into projects within broad mission categories, with each project being treated chronologically. Mission results have been categorized as: successful (s); unsuccessful (U); or, partially successful (P). These are arbitrary classifications, made after a comparison of objectives and actual results.

The information presented herein, with the exception of the "Remarks" column, has also been prepared in chart form and is available on request. Comments, criticisms, and suggestions for the improvement of this publication are solicited. Correspondence should be addressed to KSC Historical Services (IS-DOC-1H), John F. Kennedy Space Center, NASA, Kennedy Space Center, Florida 32899.

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GEOPHYSICS AND ASTRONOMY PROGRAMS

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
BEACON					
Beacon	22 Oct 58 10:22 p.m. EST	Juno I (Jupiter C) (No. 49)	--	ETR 5	Atmospheric Physics. Attempt to place a 92.6 pounds 12-foot 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 07:31 p.m. EST	Juno II (AM-19B)	--	ETR 26B	Atmospheric Physics. Attempt to orbit 12-foot 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)

GEOPHYSICS AND ASTRONOMY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
VANGUARD					
Vanguard II	17 Feb 59 10:55 a.m. EST	Vanguard SLV-4	1959 Alpha I (Satellite) 1959 Alpha II (casing)	ETR 18A	Meteorology. First fully instrumented Vanguard payload in orbit; 20.74 pounds; excessive wobble of sphere was caused by third stage bumping into satellite; cloud cover data not usable. Transmitted for 18 days, still in orbit (2023 X 346 sm, inclination 33 degrees, 125 minute period). (U)
Vanguard	13 Apr 59 09:49 p.m. EST	Vanguard SLV-5	--	ETR 18A	Second-stage failure; tumbling resulted from thrust chamber damage. (U)
Vanguard	22 June 59 04:16 p.m. EDT	Vanguard SLV-6	--	ETR 18A	Second-stage failure; helium tank burst as a result of faulty pressure regulator in propulsion system. (U)
Vanguard III	18 Sep 59 00:20 a.m. EST	Vanguard SLV-7	1959 Eta	ETR 18A	Magnetic field, radiation belt, and micro-meteoroid findings. 50-pound satellite was last launch in Vanguard program. Transmissions ceased December 11, 1959. Still in orbit (2289 X 318 sm, inclination 33 degrees, 129 minute period). (S)

GEOPHYSICS AND ASTRONOMY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
EXPLORER					
Explorer	16 Jul 59 12:37 p.m. EDT	Juno II (AM-16)	S-1	ETR 5	Attempt to place a 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 10:23 a.m. EDT	Thor-Able III	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 October 6, 1959. Re-entered in July 1961. (S)
Explorer 7	13 Oct 59 11:31 a.m. EDT	Juno II (AM-19A)	S-1a	ETR 5	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 (654 X 342 sm, inclination 50 degrees, 100 minute period). (S)

GEOPHYSICS AND ASTRONOMY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer	23 Mar 60 08:35 a.m. EST	Juno II (AM-19C)	S-46	ETR 26B	Attempt to orbit satellite equipped to analyze radiation energies in the Van Allen radiation zones; orbit velocity not achieved due to failure of upper stages to ignite. Communication with launch vehicle was lost after second-stage burnout. (U)
Explorer 8	3 Nov 60 12:23 a.m. EST	Juno II (AM-19D)	S-30	ETR 26B	All systems functioned normally to put into an elliptical orbit a 90.14-pound scientific earth satellite which confirmed existence of helium layer in upper atmosphere. Transmitted data until December 27, 1960; still in orbit (1338 X 259 sm, inclination 50 degrees, 110 minute period). (S)
Explorer	24 Feb 61 08:05 a.m. 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 10:17 a.m. EST	Delta DM-19 (Delta-4)	P-14	ETR 17A	Satellite probe, 79-pounds, highly eccentric orbit. Transmitted data on earth and interplanetary magnetic fields and solar wind. Re-entered June 1968. (S)

GEOPHYSICS AND ASTRONOMY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 11	27 Apr 61 09:27 a.m. 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 82-pound spacecraft functioned as planned. Still in orbit (1082 X 301 sm, inclination 29 degrees, 108 minute period). (S)
Explorer	24 May 61 03:48 a.m. 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)
Explorer 12	15 Aug 61 10:21 p.m. EST	Delta DM-19 (Delta-6)	S-3	ETR 17A	83-pound spacecraft designed to provide data on magnetic fields, energetic particles, and solar wind. Data received from all experiments; transmitted until December 6, 1961; re-entered in September 1963. (S)
Explorer 14	2 Oct 62 05:11 p.m. EST	Delta DSV-3A (Delta-13)	S-3a	ETR 17B	80-pound spacecraft injected into highly elliptical orbit (61,190 X 174 sm, inclination 33 degrees, 36.4 hours period). Energetic particles experiment. Still in orbit, but orbital elements no longer maintained. Data transmission continued until August 10, 1963. (S)

GEOPHYSICS AND ASTRONOMY PROGRAMS

(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 15	27 Oct 62 06:15 p.m. EST	Delta DSV-3A (Delta-14)	S-3b	ETR 17B	A 98-pound satellite to study artificial radiation belt. High spin rate, still in orbit, but orbital elements no longer maintained. (S)
Explorer 17	2 Apr 63 09:02 p.m. EST	Delta DSV-3B (Delta-17)	S-6	ETR 17A	A 405-pound satellite studied density, pressure, composition, and temperature of the earth's upper atmosphere. Re-entered on November 24, 1966. (S)
Explorer 18	26 Nov 63 09:30 p.m. 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)
Beacon-Explorer A	19 Mar 64 06:14 a.m. 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 10:45 p.m. EST	Delta DSV-3C (Delta-26)	IMP-B	ETR 17A	Detailed study of environment of cislunar space through cosmic ray, solar wind and magnetic field measurements. The 136-pound spacecraft did not achieve an orbit in true interplanetary space as planned, but operated satisfactorily. Re-entered in January 1966. (S)

GEOPHYSICS AND ASTRONOMY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 26	21 Dec 64 04:00 p.m. 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 101-pound 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 07:00 a.m. 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. 130-pound satellite re-entered 4 July 1968. (S)
Explorer 31	28 Nov 65 11:49 p.m. EST (08:49 p.m. PST)	Thor- Agena (Thrust- Augmented) (Thor- Agena-5)	DME-A	WTR SLC- 2E	Dual launch of 218-pound spacecraft with Alouette II (total payload 541-pounds). Complemented Alouette by taking measurements of ionospheric characteristics with a companion spacecraft as part of ISIS-X program. Still in orbit; still transmitting (2823 x 323 sm, inclination 80 degrees, 120 minute period). (S)

GEOPHYSICS AND ASTRONOMY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 32	25 May 66 09:00 a.m. EST	Delta DSV-3C (Delta-38)	AE-B (S-6a)	ETR 17B	Atmosphere Explorer; the 495-pound payload was designed to collect temperature, composition, density, and pressure data to permit the study of the physics of the atmosphere on a global basis. Still in orbit (1519 X 171 sm, inclination 65 degrees, 113 minute period). (S)
Explorer 33	1 July 66 11:02 a.m. 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 125-pound spacecraft is now in a looping earth orbit (529,714 X 166,048 sm, inclination 57 degrees, 49 days, 1 hour, 53 minute period) sending back information on radiation, magnetic fields, and solar winds. (S)
Explorer 34	24 May 67 04:06 a.m. EDT (07:06 a.m. 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)

GEOPHYSICS AND ASTRONOMY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 35	19 Jul 67 10:19 a.m. EST	Delta DSV-3E (Delta-50)	IMP-E	ETR 17B	Explorer XXXV was the 50th Delta launch for NASA, of which only three have failed, a 94% success. The 235-pound satellite, an Interplanetary Monitoring Platform, studies interplanetary space phenomena with emphasis on study of solar wind and magnetic field at lunar distances. Explorer XXXV is in a selenocentric 690 X 497 sm orbit around the moon, and still transmitting. (S)
Explorer 38	4 Jul 68 11:24 a.m. EDT (08:25 a.m. PDT)	Delta DSV-3J (Delta-57)	RAE-A	WTR SLC- 2E	The 420-pound spacecraft, a Radio Astronomy Explorer, was injected into a near-circular orbit (3647 X 3625 sm, inclination 120 degrees, 3 hours, 44 minute period). 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 transmitting. (S)
Explorer 41	21 Jun 69 04:48 a.m. EDT (01:48 a.m. PDT)	Delta DSV-3E (Delta-69)	IMP-G	WTR SLC- 2W	The 174-pound spacecraft was launched into a highly elliptical (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 XVIII (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 December 23, 1972. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 43	13 Mar 71 11:11 a.m. 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 28.8 kg (635.6 lb) spacecraft into highly elliptical orbit with 206,049 km (128,039 sm) opogee, 241 km (150 sm) perigee, 28.6 deg inclination and 6012 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. (S)
Explorer 47	22 Sep 72 09:20 p.m. EDT	Delta DSV-3N-6 (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 Sep, 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 deg) to provide the optimum science. Period is 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-terrestial relationship. (S)

GEOPHYSICS AND ASTRONOMY PROGRAMS
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Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Explorer 49	10 June 73 10:13 a.m. 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 03:21 EDT 15 June, the spacecraft's lunar insertion motor was fired to place it in a lunar orbit with an apocynthion of 1334 km (829 sm) and a pericynthion of 1123 km (698 sm) at an inclination of 61.3 deg 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 (1503 ft) tip-to-tip, Explorer 49 is, in physical dimensions, the largest hand-made object to circle the Moon. Its instruments study low-frequency radio emissions from the solar system and other galactic and extragalctic sources.

GEOPHYSICS AND ASTRONOMY PROGRAMS
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Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
GEODETIC EARTH ORBITING SATELLITES (GEOS)					
GEOS I (Explorer 29)	6 Nov 65 01:39 p.m. EST	Delta DSV-3E (Delta-34)	GEOS-A	ETR 17A	First launch of an improved thrust-augmented Delta; first gravity-gradient stabilized satellite (385-pounds) 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 (1414 X 694 sm, inclination 59 degrees, 2 hour period). (S)
PAGEOS I	23 Jun 66 08:21 p.m. EDT (05:21 p.m. 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 I, aluminum covered mylar balloon, 100-foot diameter, 125-pounds. No instruments, world-wide triangulation network by optical sightings allows very accurate mapping. Still in orbit (3714 X 1473 sm, inclination 84 degrees, 3 hour period). (S)
GEOS II (Explorer 36)	11 Jan 68 11:16 a.m. EST (08:16 a.m. 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 (979 X 674 sm, inclination 106 degrees, 1/2 minute period). Spacecraft was checked out and declared operational on February 20, 1968. GEOS II will extend the investigations associated with the NGSP. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ORBITING SOLAR OBSERVATORY (OSO)					
OSO I	7 Mar 62 11:06 a.m. 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 440-pound OSO I, less than an hour of solar phenomena data had been collected from above the earth's atmosphere. Still in orbit (352 X 332 sm, inclination 33 degrees, 96 minute period). (S)
OSO 2	3 Feb 65 11:36 a.m. EST	Delta DSV-3C (Delta-29)	OSO- B-2 (S-17)	ETR 17B	Solar physics; 545-pound spacecraft for continuation of OSO I studies with added ability to scan the solar disc and part of the corona. Still in orbit (381 X 336 sm, inclination 33 degrees, 96 minute period). (S)
OSO	25 Aug 65 10:17 a.m. EST	Delta DSV-3C (Delta-33)	OSO- C	ETR 17B	Solar physics, spacecraft was similar to OSO I and OSO II. Failed to orbit due to premature ignition of the third stage. (U)
OSO 3	8 Mar 67 11:12 a.m. EST	Delta DSV-3C (Delta-46)	OSO- E-I	ETR 17A	Identical to the unsuccessful OSO C. The 627-pound spacecraft carried nine separate experiments to provide data on solar disturbances and radiation in space. In earth orbit; still transmitting (341 X 326 sm, inclination 33 degrees, 95 minute period). (S)

GEOPHYSICS AND ASTRONOMY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
OSO 4	18 Oct 67 11:58 a.m. EST	Delta DSC-3C (Delta-53)	OSO- D	ETR 17B	Solar Physics. Launched into extremely good circular orbit. All systems on 605-pound spacecraft operated nominally. Experiments conducted by Harvard College Observatory, American Science and Engineering, University College, London, Naval Research Laboratory, and Lawrence Radiation Laboratory. Still in orbit; still transmitting (347 X 327 sm, inclination 33 degrees, 96 minute period). (S)
OSO-5	22 Jan 69 11:48 a.m. EST	Delta DSV-3C (Delta-64	OSO- F	ETR 17B	Launched into an orbit with an apogee of 353.07 and a perigee of 337.77 statute miles. The 641-pound spacecraft contained 265 pounds 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 January 29. All instruments and spacecraft systems functioned normally. Launch vehicle was last of 30 Delta vehicles of this configuration, all of which performed successfully. (S)

GEOPHYSICS AND ASTRONOMY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
OSO-6	9 Aug 69 03:52 a.m. EDT	Delta DSV-3N (Delta-72)	OSO- G	ETR 17A	The 647-pound spacecraft was successfully injected into a 348 X 308 statute mile orbit, at an inclination of 33 degrees. 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 Packaged Attitude Control (PAC) spacecraft, rigidly attached to the second stage, into a 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. (S)

GEOPHYSICS AND ASTRONOMY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
OSO 7	29 Sep 71 05:45 a.m. 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 burn of second stage affected second burn performance, causing the 637 kg (1403 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. Still in orbit: 447 x 300 km (278 x 186 sm), 33 deg inclination, 92 minute period. (S)

GEOPHYSICS AND ASTRONOMY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ORBITING GEOPHYSICAL OBSERVATORY (OGO)					
OGO I	4 Sep 64 08:23 p.m. EST	Atlas-Agena SLV-3 (Atlas-Agena-10)	OGO-A	ETR 12	First orbiting geophysical observatory, designed to conduct numerous space experiments simultaneously. The 1073-pound OGO-A carried 20 tests. Failure to lock into earth orbit resulted in solar panels generating insufficient power to complete all experiments. Considered successful since 75% of planned data acquisition was obtained. Still in orbit; still transmitting (70,861 X 22,210 sm, inclination 58 degrees, 2 days, 16 hour, 3 minute period). (S)
OGO II	14 Oct 65 09:11 a.m. EST (06:11 a.m. 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. 1150-pound 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 October 24, 1965. Still in orbit (862 X 257 sm, inclination 87 degrees, 103 minute period). (P)

GEOPHYSICS AND ASTRONOMY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
OGO III	6 Jun 66 09:48 p.m. 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. 1135-pound spacecraft still in orbit; still transmitting, (71,935 X 4097 SM, inclination 65 degrees, 2 days, 33 minute period). (S)
OGO IV	28 Jul 67 09:21 a.m. EST (06:21 a.m. PDT)	Thor-Agena (Thrust-Augmented) Thora-Agena-8)	OGO-D	WTR SLC-2E	1240 pound 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 August 16, 1972. (S)

GEOPHYSICS AND ASTRONOMY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
OGO V	4 Mar 68 08:06 a.m. 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 restarted, injecting the 1347-pound 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 using Atlas-Agena vehicle. Last NASA launch from Launch Complex 13, Cape Kennedy. Still in orbit; still transmitting (49,364 X 41,700 sm, inclination 46 degrees, 2 days, 14 hours, 24 minutes period). (S)
OGO VI	5 Jun 69 10:42 a.m. EDT (07:42 a.m. PDT)	Thor-Agena (Thrust-Augmented) (Thor-Agena-11)	OGO-F	WTR SLC-2E	The 1394-pound OGO-VI spacecraft, last in the currently-programmed OGO series, carried 25 experiments for detailed studies near solar maximum of 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; still transmitting (682 X 246 sm, inclination 82 degrees, 99 minute period). (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ORBITING ASTRONOMICAL OBSERVATORY (OAO)					
OAO 1	8 Apr 66 02:35 p.m. 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. 3900-pound spacecraft stopped operating after two days due to battery failure ending communications. However, it is still in orbit (499 X 491 sm, inclination 35 degrees, 101 minute period). (U)
OAO 2	7 Dec 68 03:40 a.m. EST	Atlas-Centaur (AC-16)	OAO-A2	ETR 36B	The launch vehicle successfully injected the 4400-pound spacecraft into a near-circular orbit. A total of 11 telescopes are carried on the spacecraft, divided among two experiment packages provided by the University of Wisconsin and the Smithsonian Astrophysical Observatory. The objective is to make precision observations from above the Earth's atmosphere in the relatively unexplored ultraviolet region of the spectrum. Both experiment packages are performing successfully. Still in orbit; still transmitting (482 X 477 sm, inclination 35 degrees, 100 minute period). (S)

GEOPHYSICS AND ASTRONOMY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
OAO-B	30 Nov 70 05:40 p.m. 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 2132 kg (4700 lb) spacecraft into orbit. Telemetry indicated that, although the sequence was initiated on time, the spacecraft shroud panels failed to separate properly. (U)
OAO 3 Copernicus	21 Aug 72 06:28 a.m. EDT	Atlas-Centaur (AC-22)	OAO-C	ETR 36B	Terminal countdown proceeded to liftoff with no unscheduled holds. Launch vehicle injected the 2200 kg (4900 lb) observatory into a near-perfect circular orbit: 745 x 740 km (463 x 460 sm); 35 deg inclination; 100 minute period. Following spacecraft checkout, experiment operation began on 29 Aug. By 12 Jan 73 Copernicus had completed over 2000 orbits of the Earth with all systems operating satisfactorily, and both primary and secondary mission objectives had been accomplished. Observatory operation was continued. (S)

APPLICATIONS PROGRAMS

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
APPLICATIONS TECHNOLOGY SATELLITES (ATS)					
ATS-I	6 Dec 66 09:12 p.m. EST	Atlas-Agena SLV-3 (Atlas-Agena-19)	ATS-B	ETR 12	First satellite in Applications Technology Satellite Program. The 775 pound satellite was placed in circular, equatorial synchronous orbit. Used for 15 separate experiments related to communication and meteorology and control technology. Still in orbit; still transmitting (22,239 X 22,238 sm, inclination 2 degrees, 23 hour 56 minute period). (S)
ATS-2	5 Apr 67 10:23 p.m. EST	Atlas-Agena SLV-3 (Atlas-Agena-21)	ATS-A	ETR 12	Purpose of 715-pound 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 September 2, 1968. (P)

APPLICATIONS PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ATS-3	5 Nov 67 06:37 p.m. EST	Atlas-Agena SLV-3 (Atlas-Agena-25)	ATS-C	ETR 12	Third in current 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 1574-pound 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 22,200 statute miles and about 47 degrees West longitude. Transmitted excellent quality high-resolution photos of entire visible disk of Earth. Still in orbit; still transmitting (22,238 X 22,237 sm, inclination 0 degree, 23 hour, 56 minute period). (S)

APPLICATIONS PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ATS-4	10 Aug 68 06:33 p.m. 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 ingition did not occur, and attempts to separate the ATS-D from the Centaur were unsuccessful. Although the mission was a failure, the 860-pound satellite attained orbit and was therefore designated ATS-IV. 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 totalling 23 hours firing time. Satellite and Centaur stage re-entered the atmosphere on October 17, 1968. (P)

APPLICATIONS PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ATS-5	12 Aug 69 07:01 a.m. 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 degrees 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, jeopardizing usefulness of some primary experiments although spacecraft itself is in good condition. Still in orbit (22,342 X 21,651 sm). (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
EARTH RESOURCES TECHNOLOGY SATELLITES (ERTS)					
ERTS 1	23 Jul 72 02:06 p.m. EDT (11:06 a.m. 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 lift-off 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 a first stage anomaly. 941 kg (2075 lb) spacecraft, based on the Nimbus design, was injected into a near-circular orbit: 907 x 900 km (564 x 558 sm); 99 deg 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. (S)

INTERNATIONAL PROGRAMS

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ARIEL					
Ariel I	26 Apr 62 01:00 p.m. EST	Delta DM-19 (Delta-9)	S-51 (UK-1)	ETR 17A	First international satellite, joint U.S.-U.K. venture. The 132-pound spacecraft performed ionospheric and solar radiation studies. Still in orbit; transmitted until November 1964 (595 X 235 sm, inclination 54 degrees, 98 minute period). (S)

INTERNATIONAL PROGRAMS
(continued)

Mission Name	Launch Date, Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
SKYNET					
Skynet I	21 Nov 69 07:37 p.m. 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 22,797 sm, perigee of 21,563 sm, and inclination of 26 degrees, and a period of 11 hours. The spacecraft was then turned over to the United Kingdom for operation. (S)
Skynet II	19 Aug 70 08:11 a.m. 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 23,265 sm and a perigee of 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 half way through the apogee motor burn. NORAD is conducting a search for the spacecraft. (S)

INTERNATIONAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ALOUETTE					
Alouette I	29 Sep 62 02:00 a.m. EST (11:00 p.m. 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 320-pound 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 300 miles above the earth varied greatly and increased with latitude. Still in orbit; still transmitting (644 X 620 sm, inclination 80 degrees, 105 minute period). (S)
Alouette II	28 Nov 65 11:49 p.m. EST (08:49 p.m. PST)	Thor-Agena-5	Alouette B DME-A	WTR SLC-2E	Dual launch with Explorer XXXI. Initiated a NASA-Canadian International Satellites for Ionospheric (ISIS) program. Satellites were placed in near duplicate orbits. Eight experiments of Explorer XXXI were correlated with five of 323-pound Alouette II. Extended to polar regions ionospheric soundings begun by Alouette I. Still in orbit; still transmitting (1831 X 316 sm, inclination 80 degrees, 121 minute period). (S)

INTERNATIONAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ISIS-I	30 Jan 69 01:46 a.m. EST (10:46 p.m. PST)	Delta DSV-3E (Delta-65)	ISIS- A	WTR SLC- 2E	Launched into a near-polar orbit with an apogee of 2189 and a perigee of 356 statute miles. The International Satellite for Ionospheric Studies (ISIS) is 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, 520-pound, Canadian-built satellite was placed in the operational mode on 4 February. Nine of the ten joint experiments on board are operational. (S)

INTERNATIONAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ISIS 2	31 Mar 71 09:57 p.m. EST (06:57 p.m. PST)	Delta DSV-3E (Delta-84)	ISIS-A	WTR SLC-2E	264 kg (582 lb) spacecraft, containing 12 experiments provided by Canadian and U.S. investigators, was launched into near-circular orbit: 1423 x 1355 km (884 x 842 sm); 88 deg 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. (S)
ANIK 1	9 Nov. 72 08:14 p.m. 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 lbs). Remaining strap-ons ignite 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 (1240 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 deg W. longitude to provide television, radio and telephone service for all of Canada. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ANIK 2	20 Apr 73 06:47 p.m. 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 despatched 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 (1247 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 deg W. longitude. Satellite expands Canadian television, radio, and telephone coverage initiated by ANIK 1. (S)

INTERNATIONAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
HEOS-A	5 Dec 68 01:55 p.m. 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 237-pound, 16-sided spacecraft was successfully injected into an elliptical orbit (138,108 X 262 sm, inclination 28 degree, 4 days, 15 hours, 40 minute period). Following verification of orbit, spacecraft control was turned over to the ESRO Operations Center. Still transmitting; still in orbit (138,108 X 262 sm, inclination 23 degrees, 4 days, 15 hours, 40 minute period). (S)

INTERNATIONAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
TD 1	11 Mar 72 08:55 p.m. EST (05:55 p.m. 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 lbs). 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 (1038 lb) spacecraft was successfully injected into near-circular orbit of 542 x 523 km (337 x 325 sm); 98 deg 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. (S)

INTERNATIONAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
NATO					
NATO I	20 Mar 70 06:52 p.m. 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 Satellite Control Facility at Sunnyvale, California, and placed in operation. Still in orbit, still transmitting (22,568 X 21,276 sm, inclination 2.64 degrees, 1410 minute period). (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
NATOSAT 2	2 Feb 71 08:41 p.m. 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 lbs). 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 deg W. longitude. (S)

SPACE BIOLOGY PROGRAMS

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
BIOLOGICAL MISSIONS					
Bioflight 1 (Monkey Gordo)	13 Dec 58 03:49 a.m. EST	Jupiter AM-13	--	ETR 26B	Army-launched missile with capsule containing squirrel monkey Gordo. The vehicle climbed to an altitude of 300 sm and traveled 1500 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 (Monkies Able and Baker)	28 May 59 03:35 a.m. EDT	Jupiter AM-18	--	ETR 26B	Two monkeys, a 7-pound rhesus and 1-pound squirrel, were launched to an altitude of 300 miles 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 was measured and recorded. The capsule was recovered with the animals unharmed. Not a NASA mission, but data was utilized in Project Mercury planning. (S)

SPACE BIOLOGY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
BIOSATELLITES (BIOS)					
BIOS I	14 Dec 66 02:20 p.m. 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 937-pound 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 February 15, 1967, landing near Australia. A search was performed but they could not be located. (P)
BIOS II	7 Sep 67 06:04 p.m. EST	Delta DSV-3G (Delta-51)	BIOS- B	ETR 17B	Objectives were similar to those of BIOS-A. The 955-pound 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 15 miles of predicted impact point on September 9, 1967. Remainder of satellite re-entered atmosphere on October 4, 1967. (S)

SPACE BIOLOGY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
BIOS-III	28 Jun 69 11:16 p.m. EDT	Delta DSV-3N (Delta-70)	BIOS-D	ETR 17A	Third spacecraft designed for biological experimentation in space and subsequent recovery of specimens. The 1493-pound, 8-foot long spacecraft consisted of a re-entry section containing an instrumented 15-pound pigtail monkey and an adapter section containing most spacecraft systems. The spacecraft was launched into a 245 X 224 sm orbit with an inclination of about 34 degrees. 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 spacecraft re-entered January 20, 1970. (P)

METEOROLOGICAL PROGRAMS

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
TIROS R&D (TEST INFRA-RED OBSERVATION SATELLITES)					
Tiros I	1 Apr 60 06:40 a.m. EST	Thor-Able	A-1	ETR 17A	First true meteorological satellite, weighing 270-pounds. Photographed cloud cover and transmitted over 22,000 photographs between April 1 and June 17, 1960. Demonstrated that satellites can be used to survey other surface features from space. Still in orbit (459 X 429 sm, inclination 48.3 degrees, 99 minute period). (S)
Tiros II	23 Nov 60 06:13 a.m. EST	Delta DM-19 (Delta-3)	Tiros-B A-2	ETR 17A	The 270-pound 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 (447 x 382 sm, inclination 48.5 degrees, 98 minute period). (S)
Tiros III	12 Jul 61 05:25 a.m. EST	Delta DM-19 (Delta-5)	Tiros-C A-3	ETR 17A	The 285-pound 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 III spotted 50 tropical storms during the summer of 1961. Still in orbit (505 X 459 sm, inclination 48 degrees, 100 minute period). (S)

METEOROLOGICAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Tiros IV	8 Feb 62 07:44 a.m. EST	Delta DM-19 (Delta-7)	Tiros- D A-9	ETR 17A	All systems on the 285-pound spacecraft provided good data. Clarity of pictures from the new wide-angle lens was outstanding. Photos unclear after June 14, 1962. Still in orbit (521 X 439 sm, inclination 48 degrees, 100 minute period). (S)
Tiros V	19 Jun 62 07:19 a.m. EST	Delta DM-19 (Delta-10)	Tiros- E A-50	ETR 17A	The 285-pound 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 (599 X 365 sm, inclination 58 degrees, 100 minute period). (S)
Tiros VI	18 Sep 62 03:53 a.m. EST	Delta DM-19 (Delta-12)	Tiros- F A-51	ETR 17A	Launch moved up from November to cover storm season. The 281-pound spacecraft performed as planned. One camera failed December 1, 1962. Still in orbit (436 X 426 sm, inclination 58 degrees). (S)
Tiros VII	19 Jun 63 04:50 a.m. EST	Delta DSV-3B (Delta-19)	Tiros- G A-52	ETR 17B	This 297-pound Tiros was the first to carry an electron temperature and density probe. Still in orbit (397 X 381 sm, inclination 58 degrees, 97 minute period). (S)

METEOROLOGICAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Tiros VIII	21 Dec 63 04:30 a.m. EST	Delta DSV-3B (Delta-22)	Tiros- H A-53	ETR 17B	Eighth successful Tiros launch; the primary mission of the 265-pound 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 (461 x 439 sm, inclination 59 degrees, 99 minute period). (S)
Tiros IX	22 Jan 65 02:52 a.m. EST	Delta DSV-3C (Delta-28)	Tiros- I A-54	ETR 17A	First 305-pound Tiros cartwheel configuration, for increased coverage of world cloud cover; elliptical polar orbit. Still in orbit (1604 X 439 sm, inclination 96 degrees, 119 minute period). (S)

METEOROLOGICAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
TIROS OPERATIONAL					
Tiros X	1 Jul 65 11:07 p.m. EST	Delta DSV-3C (Delta-32)	OT-I	ETR 17B	First Weather Bureau funded spacecraft; spin-stabilized, 280-pound spacecraft with two 104° TV cameras, similar to Tiros VI. Placed in near polar sun synchronous orbit to obtain more daily photo data on storm breeding areas of hurricanes and typhoons then previously available. Still in orbit (519 X 462 sm, inclination 98 degrees, 101 minute period). (S)
ESSA I	3 Feb 66 02:41 a.m. EST	Delta DSV-3C (Delta-36)	OT-3 (TOS)	ETR 17A	The 305-pound, 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 (521 X 437 sm, inclination, 98 degrees, 100 minute period). (S)
ESSA II	28 Feb 66 08:58 a.m. EST	Delta DSV-3E (Delta-37)	OT-2 (TOS)	ETR 17B	Advanced 290-pound version of the cartwheel configuration. Permits local readout of daylight cloud cover by Automatic Picture Transmission (APT) TV system. Polar, sun synchronous orbit; transmitting on command (879 X 844 sm, inclination 101 degrees, 113 minute period). (S)

METEOROLOGICAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ESSA III	2 Oct 66 06:39 a.m. EDT (03:39 a.m. PDT)	Delta DSV-3E (Delta-41)	TOS-A	WTR SLC- 2E	This 326-pound spacecraft was launched to replace ESSA I. Near polar, sun synchronous orbit. Provided daily global photographic coverage. Advanced cartwheel design. Replaced by ESSA V, but still in orbit (425 X 863 sm, inclination 101 degrees, 115 minute period). (S)
ESSA IV	26 Jan 67 12:31 p.m. EST (09:31 p.m. PST)	Delta DSV-3E (Delta-45)	TOS-B	WTR SLC- 2E	The 295-pound 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 II, whose usefulness was limited by orbital drift. Still in orbit (896 X 825 sm, inclination 102 degrees, 113 minute period). (S)
ESSA V	20 Apr 67 06:21 a.m. EST (03:21 a.m. PST)	Delta DSV-3E (Delta-48)	TOS-C	WTR SLC- 2E	The 325-pound spacecraft was successfully launched into a near polar sun synchronous orbit. Carried two Advanced Vidicon Camera Systems to provide 24 hour global weather coverage. Turned over to ESSA May 8. Still in orbit; still transmitting on command (884 X 843 sm, inclination 102 degrees, 114 minute period). (S)

METEOROLOGICAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ESSA VI	10 Nov 67 12:53 p.m. EST (09:53 a.m. PST)	Delta DSV-3E (Delta-54)	TOS-D	WTR SLC- 2E	This 299-pound 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; still transmitting (924 X 876 sm, inclination 102 degrees, 115 minute period). (S)
ESSA VII	16 Aug 68 07:24 a.m. EDT (04:24 a.m. 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 VII was successfully launched into the desired orbit. The 340-pound 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; still transmitting on command (917 X 890 sm, inclination 102 degrees, 115 minute period). (S)

METEOROLOGICAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ESSA VIII	15 Dec 68 12:21 p.m. EST (09:21 a.m. 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 provides maximum coverage of the illuminated Earth. The 18-sided, 300-pound, 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; still transmitting (910 X 879 sm, inclination 102 degrees, 115 minute period). (S)

METEOROLOGICAL PROGRAMS

(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ESSA IX	26 Feb 69 02:47 a.m. EST	Delta DSV-3E (Delta-67)	TOS-G	ETR 17B	The 247-pound 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 2000 miles southwest of Cape Kennedy, 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; still transmitting on command (936 X 884 sm, inclination 102 degrees, 115 minute period). (S)

METEOROLOGICAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
IMPROVED TIROS OPERATIONAL					
ITOS-1 & OSCAR-5	23 Jan 70 06:31 a.m. EST (03:31 a.m. 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 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 were: Apogee, 919 sm, perigee 890 sm, inclination 115 degrees, 102 minute period). (S)

METEOROLOGICAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
NOAA 1	11 Dec 70 06:35 a.m. EST (03:35 a.m. PST)	Delta DSV-3L (Delta-81)	ITOS-A	WTR SLC-2W	309 kg (682 lb) spacecraft, first operational 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 1472 x 1423 km (915 x 884 sm) orbit with 102 deg 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 lbs). 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 liftoff. Launch vehicle also carried into orbit a Cylindrical Electrostatic Probe Experiment (CEPE) as a secondary payload attached to second stage. (S)

METEOROLOGICAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ITOS B	21 Oct 71 07:32 a.m. EDT (04:32 a.m. 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 01:19 p.m. EDT (10:19 a.m. 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 Oct 13 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 1454 x 1448 km (903 x 900 sm) with an inclination of 102 deg, a 115 minute period, and an equator crossing time of 08:48 a.m. and p.m. 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.

Mission Name	Launch Data/Time	Launch Vehicle	NASA CODE	Site/ Pad	Remarks/Results
ITOS	16 Jul 73 1:10 p.m. EDT (10:10 P.M.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)

METEOROLOGICAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
NIMBUS					
Nimbus I	28 Aug 64 03:57 a.m. EDT (00:57 a.m. 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 cut-off resulted in an elliptical, rather than the desired circular, polar orbit. Stabilized, Earth-oriented, 830-pound spacecraft carried three types of sensors: Advanced Videcon 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. Still in orbit (465 X 254 sm, inclination 99 degrees, 96 minute period). (S)

METEOROLOGICAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Nimbus 2	15 May 66 03:56 a.m. EDT (00:56 a.m. PDT)	Thor-Agena (Thrust-Augmented) (Thor-Agena-6)	Nimbus B	WTR SLC-2E	Launched into near-circular, near-polar orbit. All systems aboard 912-pound spacecraft functioned successfully. At end of first year in orbit, Nimbus II had maintained 3-axis, Earth-oriented stabilization and had relayed more than a million photographs. Ceased operations January 17, 1969. Still in orbit (734 X 682 sm, inclination 100 degrees, 108 minute period). (S)
Nimbus	18 May 68 01:23 a.m. EDT (04:23 a.m. 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 "piggy-back" 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)

METEOROLOGICAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Nimbus 3 and SECOR	13 Apr 69 02:54 a.m. EST (11:54 p.m. PST)	Thor-Agena (Thrust-Augmented) Thor-Agena-LO)	Nimbus B-2	WTR SLC-2E	The fourth of seven spacecraft in the currently planned Nimbus series was essentially a repeat of the unsuccessful Nimbus B mission. The 1360-pound 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. Still in orbit (706 X 668 sm, inclination 100 degrees, 107 minute period); transmitting on command. (S)
Nimbus 4 and TOPO-A	8 Apr 70 03:18 a.m. EST (12:18 p.m. PST)	Thor-Agena (Thrust-Augmented)	Nimbus 4	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 is performing well. The NIMBUS is designed to take measurements that will provide selected vertical profiles of temperature, water vapor, and ozone content of the atmosphere from ground level upward. The spacecraft is operating satisfactorily in a nearly circular orbit (apogee 683 sm, perigee 676 sm, inclination 100 degrees, 107 minute period). (S)

METEOROLOGICAL PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Nimbus 5	11 Dec 72 02:56 a.m. EST (10 Dec 72) (11:56 p.m. 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 (1702 lb) Nimbus 5, sixth in the current 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 1101 x 1089 km (684 x 676 sm) at an inclination of 100 degrees and a 107-minute period. (S)

COMMUNICATIONS AND NAVIGATION PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ECHO					
Echo	13 May 60 04:16 a.m. EST	Delta DM-19 (Delta-1)	A-10	ETR 17A	First use of the Delta launch vehicle; attempt to orbit a 100-foot diameter 132-pound 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 I	12 Aug 60 04:40 a.m. EST	Delta DM-19 (Delta-2)	A-11	ETR 17A	First passive communications satellite; the 100-foot diameter, 166-pound 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 1207 sm apogee and 1089 sm perigee. Slowly lost its spherical shape due to meteorite punctures and escape of internal gases. Re-entered atmosphere May 24, 1968. (S)
Echo (Test)	15 Jan 62 06:07 a.m. 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 535-pounds, 135 foot diameter sphere. Canister ejection successful, but too rapid inflation ripped balloon apart at 250 mile altitude. All test objectives were accomplished, and capsule with movie film re-entered and was recovered. (P)

COMMUNICATIONS AND NAVIGATION PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Echo (Test)	18 Jul 62 04:30 a.m. 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 535-pound sphere was visible for 10 minutes from Cape Canaveral. It was the largest man-made object sent into space, the previous record being held by Echo I. Not intended as an orbital shot, AVT-2 re-entered July 27, 1962. (S)
Echo II	25 Jan 64 07:59 a.m. EST (04:59 a.m. PST)	Thor-Agena DM-21 (Thor-Agena-2)	A-12	WTR SLC-2E	Passive communications satellite, an aluminized plastic 535 pound balloon, 135 feet in diameter. International communications experiments between U.K, U.S.S.R., and U.S. Re-entered atmosphere June 7, 1969. (S)

COMMUNICATIONS AND NAVIGATION PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
TELSTAR					
Telstar I	10 Jul 62 03:35 a.m. EST	Delta DM-19 (Delta-11)	A-40	ETR 17B	This 170-pound, 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 November 23, 1962, but was restored on January 4, 1963, and continued until February 21, 1963. Still in orbit (3501 X 592 sm, inclination 45 degrees, 158 minute period). (S)
Telstar II	7 May 63 06:38 EST	Delta DSV-3B (Delta-18)	A-41	ETR 17B	This 175-pound, 34.5-inch 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 U.S.A., France, and England. Still in orbit (6709 X 605 sm, inclination 43 degrees, 225 minute period). (S)

COMMUNICATIONS AND NAVIGATION PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
RELAY					
Relay I	13 Dec 62 06:30 p.m. EST	Delta DSV-3B (Delta-15)	A-15	ETR 17A	This octagonal 172-pound 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 (4619 X 822 sm , inclination 47 degrees, 185 minute period). (S)
Relay II	21 Jan 64 04:15 p.m. EST	Delta DSV-2B (Delta-23)	A-16	ETR 17B	Similar to Relay I, but had longer expected operating time, more efficient orbit, and internal changes designed to improve operation over earlier version. The 183.6 pound spacecraft successfully transmitted television test patterns at the end of its first orbit, and performed successfully when tested on subsequent orbits. Still in orbit; (4264 X 1278 sm, inclination 46 degrees, 195 minute period). (S)

COMMUNICATIONS AND NAVIGATION PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
SYNCOM					
Syncom I	14 Feb 63 00:35 a.m. EST	Delta DSV-3B (Delta-16)	A-25	ETR 17B	First NASA attempt for near-synchronous, 24-hour orbit successful. The 86-pound cylindrical satellite transmitted data during launch, then went silent. Was lost until location in desired orbit was confirmed by photographs March 1, 1963. Still in orbit, but current elements not maintained. (P)
Syncom II	26 Jul 63 09:33 a.m. EST	Delta DSV-3B (Delta-20)	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 August 15. Reached an altitude of 22,300 miles and a speed of 6,800 mph, matching the earth's rotation speed of 1,040 mph at the equator to keep it on station. Still in orbit. (S)
Syncom III	19 Aug 64 07:15 a.m. EST	Delta DSV-3D (Delta-25)	A-27 Syncom C	ETR 17A	First launch of a Delta using strap-on solid motors (3) to increase first stage thrust. Syncom III 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 III. Still in orbit. (S)

COMMUNICATIONS AND NAVIGATION PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
COMMERCIAL (COMSAT CORPORATION)					
Intelsat I (Early Bird 1)	6 Apr 65 06:47 p.m. 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 240 voice channels, television or high speed data between North America and Europe. Still in geostationary orbit over Atlantic, 27.5° west longitude. (S)
Intelsat II-A (Pacific)	26 Oct 66 06:05 p.m. 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. 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. (P)
Intelsat II-B (Pacific I)	11 Jan 67 05:55 a.m. 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°E), it provided communications for NASA and commercial users. Still in orbit. (S)

COMMUNICATIONS AND NAVIGATION PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat II (Atlantic 2)	22 Mar 67 08:30 p.m. EST	Delta DSV-3E (Delta-47)	F-3	ETR 17B	Fourth ComSat commercial satellite. Placed in geostationary orbit over the Atlantic at 5°W for communication service between North and South America and Europe. Still in orbit. (S)
Intelsat II (Pacific 2)	27 Sep 67 08:45 p.m. 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 (Pacific I). Still in geostationary orbit over Pacific at about 176°E. (S)
Intelsat III	18 Sep 68 06:09 p.m. EDT	Delta DSV-3M (Delta-59)	III-A	ETR 17A	First of several spacecraft planned to improve global communication network. Intelsat III's are 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)

COMMUNICATIONS AND NAVIGATION PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat III	18 Dec 68 07:32 p.m. EST	Delta DSV-3M (Delta-63	F-2	ETR 17A	Successfully launched for Comsat Corporation into a temporary elliptical orbit with an apogee of 22,820 sm and perigee of 163 sm, at an inclination to the equator of 30 degrees. Its apogee kick motor was fired on 20 December and maneuvered it into a synchronous orbit over the Atlantic equator, at 31 degrees west longitude and an altitude of 22,200 sm. All systems functioned normally. The second of the Intelsat III series (the first to be successfully orbited), the 632-pound cylindrical spacecraft has the capability of handling 1200 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. (S)
Intelsat III	5 Feb 69 07:39 p.m. EST	Delta DSV-3M (Delta-66)	F-3	ETR 17A	Successfully launched for ComSat Corporation into an elliptical orbit, with an apogee of 22,434 sm. a perigee of 165 sm, inclination of 29 degrees, 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 642-pound spacecraft has the capability of handling 1200 two-way voice circuits, or television, teletype, facsimile, and digital transmission. Repositioned over Indian Ocean at 62.5° E. Long and began service there on July 1, 1969. (S)

COMMUNICATIONS AND NAVIGATION PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat III-D	21 May 69 10:00 p.m. EST	Delta DSV-3M (Delta-68)	F-4	ETR 17A	Successfully launched for ComSat Corporation into an elliptical orbit, with an apogee of 22,926 sm, a perigee of 174 sm, inclination of 29 degrees, 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 has the capability of handling 1200 two-way voice circuits, or television, teletype, facsimile, and digital transmission. (S)
Intelsat III-E	25 Jul 69 02:06 a.m. EST	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. (U)

COMMUNICATIONS AND NAVIGATION PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat III-F	14 Jan 70 07:16 p.m. 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 22,290 sm, a perigee of 180 sm, inclination of 28 degrees, and a period of 634 minutes. The 647-pound spacecraft was placed in a near-synchronous orbit by a burn of its apogee kick motor on January 16, 1970, and began operating. Similar in capability to all preceding Intelsat spacecraft, this was the first launch insured against failure by a commercial company. (S)
Intelsat III-G	22 Apr 70 07:46 p.m. EST	Delta DSV-3M (Delta-78)	F-7	ETR 17A	This was the seventh Intelsat III launched for the ComSat Corporation. The 647-pound spacecraft was placed in a slightly low temporary orbit, with an apogee of 19,846 sm, a perigee of 162 sm, and an inclination of 27 degrees. 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. (S)

COMMUNICATIONS AND NAVIGATION PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat III-H	23 Jul 70 07:23 p.m. 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 647-pound spacecraft had the same capabilities as previous ones in the III series. The vehicle placed the spacecraft in an orbit with an apogee of 22,531 sm, a perigee of 162 sm, at an inclination of 28 degrees. 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. (S)

COMMUNICATIONS AND NAVIGATION PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat IV F-2 (Atlantic)	25 Jan 71 07:36 p.m. 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 radars 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 -- 1387 kg (3058 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 deg W longitude. (S)

COMMUNICATIONS AND NAVIGATION PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat IV F-3 (Atlantic)	19 Dec 71 08:10 p.m. EST	Atlas-Centaur (AC-26)	F-3	ETR 36A	First launch attempt on 18 Jan due to surface winds exceeding launch limitations after scheduled countdown holds were extended four minutes into the first launch window. 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 deg W longitude. (S)
Intelsat IV F-4 (Atlantic)	22 Jan 72 07:12 p.m. 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 gust 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 deg E longitude (S)

COMMUNICATIONS AND NAVIGATION PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat IV F-5 (Indian)	13 Jun 72 05:53 p.m. 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 elliptical 42,281 x 6918 km (26,273 x 4298 sm) transfer orbit, successfully completing NASA mission objective. COMSAT fired kick motor as spacecraft reached its third apogee to maneuver satellite into final position over the Indian Ocean at 62 deg E longitude. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Intelsat IV F-7 (Atlantic)	23 August 73 6:57 p.m. EDT	Atlas/ Centaur (AC 31)	F-5	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 1406 kg (3100 lb) spacecraft was injected into a 3592 X 545 km (22 334 x 338 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 30W. longitude. (S)

LUNAR AND PLANETARY PROGRAMS

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
PIONEER (Lunar)					
Pioneer I	11 Oct 58 03:42 a.m. EST	Thor-Able-I	--	ETR 17A	Lunar probe. Uneven separation of second and third stages; reached altitude of 70,717 miles. Verified Van Allen Belt and returned other useful data before payload re-entered after 43 hours. (U)
Pioneer 2	8 Nov 58 02:30 a.m. EST	Thor-Able-2	--	ETR 17A	Lunar probe. Third stage failed to ignite; reached 963 miles. 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 12:45 a.m. 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 63,580 miles to contribute major scientific discovery of dual bands of radiation around the earth. Re-entered after 38 hours, 6 minutes. (U)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Pioneer 4	3 Mar 59 12:11 a.m. EST	Juno II (AM-14)	--	ETR 5	Lunar probe. Instrumented for space radiation measurements on Earth-moon trajectory; carried photo-electric scanner for use in vicinity of moon. Trajectory caused it to pass within 37,000 miles 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 407,000 miles (greatest tracking distance for man-made object to date) before going into permanent heliocentric (solar) orbit. (S)
Pioneer	26 Nov 59 02:26 a.m. EST	Atlas-Able-1	--	ETR 14	Lunar probe. Payload shroud broke away 45 seconds after liftoff, satellite torn off. (U)
Pioneer	25 Sep 60 10:13 a.m. 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 04:10 a.m. EST	Atlas-Able-3	P-31	ETR 12	Lunar orbit attempt; exploded 70 seconds after liftoff due to first stage malfunction. (U)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
PIONEER (Planetary)					
Pioneer 5	11 Mar 60 08:00 a.m. 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 22.5 million miles on June 26, 1960, a record unmatched until Mariner II. First radio communication at interplanetary distances. In solar orbit. (S)
Pioneer 6	16 Dec 65 02:31 a.m. 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. (S)
Pioneer 7	17 Aug 66 10:20 a.m. EST	Delta DSV-3E (Delta 40)	Pioneer B	ETR 17A	Heliocentric orbit, measuring solar magnetic field, solar wind, and cosmic rays. Like Pioneer VI, continued measurements of solar activity at widely separated points in interplanetary space. Orbit of 403 days. (S)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Pioneer 8	13 Dec 67 09:08 a.m. 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 similar in appearance to Pioneers 6 and 7 but contains 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. Will also aid 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 boundry at approximately 1400 EST, December 15, 1967. On January 18, 1968 Sun, Earth and spacecraft were aligned, with spacecraft about two million miles from Earth, thus providing opportunity for further investigation of Earth's magnetic tail (first performed by Pioneer 7 in September 1966). (S)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Pioneer 9	8 Nov 68 04:46 a.m. EST	Delta DSV-3E (Delta-60)	Pioneer D	ETR 17B	Pioneer 9 was injected into a solar orbit with an aphelion of 92,091,837 sm and a perihelion of 70,061,186 sm, and a 297.5-day period. The 147-pound, 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 44-pound secondary payload, a MSFN Test and Training Satellite (TETR-B), which was injected into Earth orbit. (S)
Pioneer	27 Aug 69 05:59 p.m. 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 08:49 p.m. EST	Atlas-Centaur TE-M-364-4 (AC-27)	Pioneer F	ETR 36A	Pioneer 10 is first NASA mission to extend the study of interplanetary phenomena beyond the orbit of Mars, first to penetrate the asteroid belt and provide close-up viewing of Jupiter, and first man-made object to escape our solar system. The AC-27 launch vehicle consisted of an Atlas SLV-3C first stage, a Centaur D second stage, and a new, spin-stabilized third stage incorporating a TE-M-364-4 solid propellant motor. The 258 kg (569 lb) spin stabilized Pioneer is first spacecraft to be entirely powered by Radioisotope Thermal Generators (RTG's) and capable of operating beyond the influence of the Sun. First launch attempt on 27 Feb was scrubbed at T-59 minutes and holding due to a prediction of unfavorable upper winds at T-0. Second and third launch attempts, on 28 Feb and 1 Mar, were both scrubbed at T-5 minutes and holding due to unfavorable upper winds. Fourth launch attempt on 2 Mar proceeded smoothly until T-75 seconds, when indications of a Centaur propellant tanking problem prevented initiation of the engine start sequence. Count was recycled to T-5 minutes and held while problem was solved, then picked up and continued to liftoff 24 minutes into the 30 minute launch window. Direct ascent at highest launch velocity ever attained successfully injected Pioneer 10 spacecraft into desired hyperbolic trajectory.

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Pioneer 11	5 Apr 73 07:11 p.m. EST	Atlas-Centaur TE-M-364-4 (AC-30)	Pioneer G	ETR 36B	The 259 kg (571 lb) Pioneer 11 was the second in a series of scientific spacecraft designed to fly beyond the orbit of Mars, pass through the asteroid belt, gain speed while performing a fly-by of Jupiter, and continue on into space, returning information from previously unexplored parts of the solar system and beyond. The AC-30 launch vehicle consisted of an Atlas SLV-3D first stage, a Centaur D-1A second stage, and a modified Delta third stage with a TE-M-364-4 solid propellant motor. Although poor weather conditions, including lightning, on the day before launch required clearing the pad for several hours and delayed some pre-countdown activities, the count began at the scheduled time and proceeded smoothly through all planned hold to liftoff. The direct ascent powered flight injected the spacecraft into the desired hyperbolic trajectory at a velocity of about 52,000 km per second (32,400 mph). The refined trajectory of Pioneer 11 will not be determined until about one year after launch. Based on the receipt and evaluation of data from Pioneer 10, Pioneer 11 may be programmed to repeat the fly-by performed by the first mission, swing in closer or further from Jupiter, fly-by on a different trajectory, or travel on past Jupiter to Saturn. It is anticipated that data will be returned from the spacecraft, subject to equipment functioning, out to a limit of about 18 Astronomical Units -- a distance of 3,692,782,000 km, or 1,673,313,951 sm -- and for about five and ¼ years after planetary fly-by.

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
RANGER					
Ranger I	23 Aug 61 05:04 a.m. EST	Atlas-Agena	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 August 30, 1961. (U)
Ranger II	18 Nov 61 03:12 a.m. EST	Atlas-Agena	P-33	ETR 12	Lunar probe. Placed in low earth orbit rather than programmed deep space orbit. Test of spacecraft achieved. Re-entered Nov. 30, 1961. (U)
Ranger III	26 Jan 62 03:30 p.m. EST	Atlas-Agena	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 22,862 miles. Provided first measurement of interplanetary gamma ray flux. Entered solar orbit. (U)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Ranger IV	23 Apr 62 03:50 p.m. EST	Atlas-Agena	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 correction. Crashed onto backside of moon on April 26, 1962. While full flight objectives were not achieved, a high order of performance in the Atlas-Agena/Ranger combination was demonstrated. (P)
Ranger V	18 Oct 62 11:59 a.m. EST	Atlas-Agena	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 450 miles of moon and on into solar orbit; tracked to distance of 790,000 miles. (P)
Ranger VI	30 Jan 64 10:49 a.m. 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 900 to 4 miles. Ranger impacted in the Sea of Tranquility at 4:24 a.m. EST on February 2, precisely on schedule. (P)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Ranger VII	28 Jul 64 12:50 a.m. EDT	Atlas-Agena SLV-3 (Atlas-Agena-9)	Ranger B (P-54)	ETR 12	The 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 July 31, 1964. All aspects of the test were successful. (S)
Ranger VIII	17 Feb 65 12:05 a.m. EST	Atlas-Agena SLV-3 (Atlas-Agena-13)	Ranger C	ETR 12	Lunar photography. 7,137 pictures obtained; impact occurred about 15 miles from target in Sea of Tranquility on February 20, 1965. (S)
Ranger IX	21 Mar 65 04:37 p.m. EST	Atlas-Agena SLV-3 (Atlas-Agena-14)	Ranger D	ETR 12	Lunar photography. 5,814 pictures obtained; impact only a few miles from target in eastern floor of crater of Alphonsus, March 24, 1965. Pictures converted for live viewing on commercial TV. Final mission of Ranger series. (S)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
LUNAR ORBITER					
Lunar Orbiter I	10 Aug 66 02:26 p.m. 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 117 to 1159 miles, later lowered to 25 miles at perilune. Total of 207 frames taken; high-resolution camera picture smeared, medium resolution excellent. Terminated by crashing into moon on October 29, 1966 to avoid conflict with LO-2. (S)
Lunar Orbiter II	6 Nov 66 06:21 p.m. EST	Atlas-Agena SLV-3 (Atlas-Agena-18)	LO-B	ETR 13	Orbited Moon at perilune of 31 miles and photographed 13 primary target sites for Apollo landing. Returned 205 high-resolution photos before pictures stopped December 6 (one day early), when high-power transmission ceased. Also monitored radiation in lunar environment. Crashed on lunar surface October 11, 1967. (S)
Lunar Orbiter III	4 Feb 67 08:17 p.m. EST	Atlas-Agena SLV-3 (Atlas-Agena-20)	LO-C	ETR 13	Lunar orbit at perilune of 34 miles. 211 pictures of Apollo and Surveyor sites taken (72% of planned) before malfunction in priority readout system caused termination on February 24. Also continued LO-B experiments. Crashed on lunar surface October 9, 1967. (S)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Lunar Orbiter IV	4 May 67 06:25 p.m. 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 June 1. Crashed on lunar surface October 6, 1967. (S)
Lunar Orbiter V	1 Aug 67 06:33 p.m. EDT	Atlas-Agena SLV-3 (Atlas-Agena-24)	LO-E	ETR 13	Lunar orbit at 62 mile perilune. Photographed Apollo target sites, areas of scientific interest, and backside areas not previously covered. Photo readout completed August 28. Crashed on lunar surface January 31, 1968. (S)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
SURVEYOR					
Surveyor I	30 May 66 09:41 a.m. EST	Atlas-Centaur LV-3C (AC-10)	Surveyor A	ETR 36A	Soft landed on Moon in the Ocean of Storms June 2, proving capability of launch vehicle and spacecraft. Returned thousands of high-quality pictures. Selenological data obtained on morphology and lunar origin. Completed mission July 13, but spacecraft remained operable for 8 months. (S)
Surveyor II	20 Sep 66 07:32 a.m. 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 September 23. (P)
Surveyor III	17 Apr 67 02:05 a.m. EST	Atlas-Centaur LV-3C (AC-12)	Surveyor C	ETR 36B	Soft landed on Moon April 20, 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 has consistency similar to wet sand, with a bearing strength of 10 psi, firm enough for Apollo LM landing. Experiments stopped May 2, when lunar night began. Surveyor III was visited by Apollo 12 astronauts on November 20, 1969. Some parts were removed and returned to earth. (S)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Surveyor IV	14 Jul 67 07:53 a.m. EDT	Atlas-Centaur LV-3C (AC-11)	Surveyor D	ETR 36A	Carried a surface claw similar to Surveyor III, with a magnet in the claw to measure ferrous elements in lunar soil. Flight was successful until all communications with Surveyor IV were lost 2 seconds before retrorocket burnout on July 17, 1967, 2-1/2 minutes before landing. Scientists theorize that Surveyor IV spacecraft exploded. (P)
Surveyor V	8 Sep 67 03:57 a.m. EDT	Atlas-Centaur SLV-3C (AC-13)	Surveyor E	ETR 36B	Soft landed on Moon in Sea of Tranquility on September 11. Spacecraft landed on inner slope of small crater, about 30 feet in diameter and 4-1/2 feet deep, with the TV camera about 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. Shutdown for lunar night on September 24. Restarted at a later date, but subsequent data was of lower quality. Loss of signal on December 16, 1967. (S)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Surveyor VI	7 Nov 67 02:39 a.m. EST	Atlas-Centaur SLV-3C (AC-14)	Surveyor F	ETR 36B	Soft landed in Sinus Medii near Apollo Site II P-8 (3) November 9, after 53 hours, 22 minutes flight from Earth. Transmitted over 30 thousand pictures to Earth during first lunar day 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 November 17, spacecraft's three vernier engines were restarted and Surveyor VI was lifted about 13 feet off the lunar surface and translated a horizontal distance of about 10 feet. Shutdown for lunar night on November 24, 1967. (S)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Surveyor VII	7 Jan 68 01:30 a.m. EST	Atlas-Centaur SLV-3C (AC-15)	Surveyor G	ETR 36A	Last spacecraft of Surveyor series. Successfully launched from Cape Kennedy (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 08:05 p.m. EST January 9, 1968, after a flight of 66 hours, 34 minutes. Landing site (40.89 S. latitude, 11.44 W. longitude) was about 1.5 miles from aiming point. Returned over 21,000 television pictures, including some stereo pictures, 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 I, III, V, and VI. Spacecraft was shut down for its first lunar night on January 22, 1968. (S)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
MARINER					
Mariner 1	22 Jul 62 04:21 a.m. EST	Atlas-Agena	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 01:53 a.m. EST	Atlas-Agena	P-38	ETR 12	First spacecraft to scan another planet; passed within 21,600 miles of planet Venus on December 14, and made a 42 minute instrument scan of Venusian atmosphere and surface before continuing into heliocentric orbit. Transmissions from interplanetary experiments received until January 4, 1963 from 54.3 million miles distance, establishing a new communication record. (S)
Mariner 3	5 Nov 64 02:22 p.m. 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 09:22 a.m. EST	Atlas-Agena SLV-3 (Atlas-Agena-12)	Mariner 64D	ETR 12	Planetary and interplanetary exploration. Mars trajectory. Flyby occurred July 14, 1965 with closest approach between five and six thousand miles. 22 pictures were taken. In heliocentric orbit. During its 3.06 years of useful life Mariner 4 travelled more than 1.5 billion miles and returned excellent data. (S)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Mariner 5	14 Jun 67 02:01 a.m. EDT	Atlas-Agena SLV-3 (Atlas-Agena-23)	Mariner E	ETR 12	Purpose was to conduct a single flyby mission to Venus in 1967 to complement and extend results of Mariner 2. 540 lb. spacecraft passed within 2,500 miles of Venus on October 19, 1967. Measured the planet's magnetic field, ionosphere, and radiation belts and temperature. (S)
Mariner 6	24 Feb 69 08:29 p.m. EST	Atlas-Centaur SLV-3C (Atlas-Centaur-20)	Mariner F	ETR 36B	This was the first Mariner launch with the Atlas-Centaur vehicle. This spacecraft was one of a pair (with Mariner VII) launched to perform a Mars flyby almost together, and acquire data on the planet. Instruments included a Visual Imager, Ultraviolet Spectrometer, Infrared Spectrometer, temperature sensors, and others. The flyby was successful and, with Mariner VII flyby data, obtained the most detailed data on Mars to date. (S)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Mariner 7	27 Mar 1969 05:22 p.m. EST	Atlas-Centaur SLV-3C (Atlas-Centaur-19)	Mariner G	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 flyby 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 flyby from other areas of the planet. Both spacecraft entered heliocentric orbits after passing Mars. (S)

LUNAR AND PLANETARY PROGRAMS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Mariner	8 May 71 09:11 p.m. EDT	Atlas-Centaur (AC-24)	Mariner H	ETR 36A	Mariner H was first of two 998 kg (2200 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 1500 km (932 sm) downrange. (U)
Mariner 9	30 May 71 06:23 p.m. EDT	Atlas-Centaur (AC-23)	Mariner I	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 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. Primary 90-day mission was adjudged a success on 11 Feb 72. Extended mission was continued until officially terminated at 06:31 p.m. EDT 27 Oct 72. Depletion of spacecraft attitude control gas supply made it impossible to maintain stabilization and radio transmitter was turned off. (S)

VEHICLE DEVELOPMENT TESTS

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
SATURN					
Saturn	27 Oct 61 10:06 a.m. EST	Saturn C-1	SA-1	ETR 34	Successful initial flight test of first stage. Take-off thrust achieved was 1,296,000 pounds. Hurled two water-filled, dummy upper stages, carried as ballast, to peak altitude of 84.8 miles and distance of 214.7 miles down range. Reached maximum velocity of 3,607 miles per hour before plunging into ocean 8 minutes after launch. (S)
Saturn	25 Apr 62 09:01 a.m. EST	Saturn C-1	SA-2	ETR 34	Like first Saturn, fired only first stage engines, generating 1.3 million pounds of thrust. Dummy upper stages filled with water were detonated at 65 mile altitude (Project Highwater) and formed artificial cloud. All test objectives achieved. (S)
Saturn	16 Nov 62 12:45 p.m. EST	Saturn C-1	SA-3	ETR 34	First stage only; coasted to 104 mile altitude where it was destroyed to release 95 tons of water ballast into the atmosphere, forming a huge ice cloud (Project Highwater). All test objectives achieved. (S)

VEHICLE DEVELOPMENT TESTS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Saturn	28 Mar 63 03:11 p.m. 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 February 7, 1963.) (S)
Saturn	29 Jan 64 11:25 a.m. EST	Saturn I	SA-5	ETR 37B	First successful test flight of the new Block II vehicles which have powered second stages. Eight H-1 engines of the first stage operated at a rated capacity of 188,000 lb. each for a total of 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 90,000 lb of thrust. The orbited body weighed 37,700 lb., nearly 20,000 lb. of which was payload. During flight, eight onboard motion picture cameras and one TV camera provided the most elaborate optical instrumentation ever 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 20,000 pound payload. Re-entered April 30, 1966. (S)

VEHICLE DEVELOPMENT TESTS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Saturn	5 Jul 66 09:53 a.m. 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. 58,500 lb. payload consisting of S-IVB, IU and a nosecone (heaviest satellite orbited by U.S.) was injected into 117 mile circular orbit. S-IVB engine burned during launch phase, then shutdown. 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 July 5 and July 22, 1966. (S)

VEHICLE DEVELOPMENT TESTS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
CENTAUR					
Centaur	8 May 62 02:49 p.m. EST	Atlas-Centaur LV-3C (Atlas-Centaur-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 02:03 p.m. EST	Atlas-Centaur LV-3C (Atlas-Centaur-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. (S)
Centaur	30 Jun 64 09:04 a.m. EST	Atlas-Centaur LV-3C (Atlas-Centaur-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 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 of 11,425 miles per hour and an altitude of 345 miles. (P)

VEHICLE DEVELOPMENT TESTS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Centaur	11 Dec 64 09:25 a.m. EST	Atlas-Centaur LV-3C (Atlas-Centaur-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 December 12, 1964. (S)
Centaur	2 Mar 65 08:25 a.m. EST	Atlas-Centaur LV-3C (Atlas-Centaur-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)
Centaur	11 Aug 65 09:31 a.m. EST	Atlas-Centaur LV-3C (Atlas-Centaur-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. (S)
Centaur	7 Apr 66 08:00 p.m. EST	Atlas-Centaur LV-3C (Atlas-Centaur-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 May 5, 1966. (U)

VEHICLE DEVELOPMENT TESTS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Centaur	26 Oct 66 06:12 a.m. EST	Atlas-Centaur LV-3C (Atlas-Centaur-9)	AC-9	ETR 36B	Final R&D of Centaur. Primary objective was restarting 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 November 6, 1966. (S)

VEHICLE DEVELOPMENT TESTS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
SPACE ELECTRIC ROCKET					
SERT II	4 Feb 70 09:59 p.m. EST (06:59 p.m. PST)	Thor-Agena-D (Thrust-Augmented)	SERT II	WTR SLC-2E	The 3,067-pound Space Electric Rocket Test II (SERT II) 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 627 sm, perigee 620 sm, inclination 99 degrees, 105 minute period). (U)

VEHICLE DEVELOPMENT TESTS
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
FIRE (Reentry Tests)					
Fire I	14 Apr 64 04:42 p.m. 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 25,750 miles per hour; heating reached 11,200 degrees K, instead of the planned 11,300 degrees due to lower re-entry angle of 14.5 degrees instead of the planned nominal 15 degrees. Impacted 200 miles south of Ascension Island after a 32 minute flight. Test objectives achieved. (S)
Fire II	22 May 65 04:55 p.m. EST	Atlas- X259	--	ETR 12	Re-entry test. Fire II 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 25,000 miles per hour. Second and last flight of Fire program. (S)

MERCURY PROGRAM

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
SUBORBITAL					
Big Joe	9 Sep 59 03:19 a.m. EST	Mercury-BP Atlas-10D	--	ETR 14	Full-scale instrumented boilerplate model of Mercury capsule reached an altitude of 100 miles in re-entry test. Capsule recovered after surviving re-entry heat of more than 10,000°F. (S)
Mercury	29 Jul 60 09:13 a.m. EST	Mercury-4 Atlas-50D	MA-1	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)
Mercury	21 Nov 60 09:00 a.m. EST	Mercury-2 Redstone-MR-1	MR-1	ETR 5	Note: Generally not considered a launch, MR-1 rose 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 December 19, 1960 with a different booster. (U)
Mercury	19 Dec 60 11:15 a.m. EST	Mercury-2A Redstone-MR-3	MR-1A	ETR 5	Repeat of MR-1 flight mission was successful and all major objectives fulfilled. Capsule re-entered and landed in target area 235 miles down range after reaching an altitude of 135 miles and speed up to 4,300 miles per hour. Capsule recovered in excellent condition 48 minutes after launch. (S)

MERCURY PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Mercury	31 Jan 61 11:55 a.m. EST	Mercury-5 Redstone-MR-2	MR-2	ETR 5	Successfully launched fully equipped, operational Mercury capsule containing 37 pound chimpanzee named "Ham" on 16 minute suborbital flight to altitude of 156 miles and over a distance of 420 miles. 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)
Mercury	21 Feb 61 09:12 a.m. EST	Mercury-6 Atlas-67D	MA-2	ETR 14	Successful 1,425 mile flight test of Mercury capsule. Atlas shutdown prematurely to simulate an abort. After separation, capsule coasted to altitude of 107 miles; automatic stabilization and control system oriented capsule for steep entry. Attained maximum velocity of 12,850 miles per hour. 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)

MERCURY PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Mercury	24 Mar 61 12:30 p.m. EST	Mercury-BP Redstone- MR-5	MR- BD	ETR 5	Booster development test flight to verify modifications necessitated by MR-2 flight. Modified Redstone carried boilerplate Mercury capsule to an altitude of 115 miles and distance of 311 miles down range; test did not call for separation or recovery of capsule. Completely successful flight qualified Redstone for manned suborbital flights. (S)
Freedom 7	5 May 61 09:34 a.m. EST	Mercury-7 Redstone- MR-7	MR-3	ETR 5	First U.S. suborbital manned space flight. After reaching peak altitude of 116 miles and velocity of 5,180 miles per hour, Mercury capsule, manned by astronaut Alan B. Shepard, Jr., landed in Atlantic Ocean 302 miles down range 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 man can control a vehicle during weightlessness and high G stresses, and suffer no adverse physiological effects. (S)

MERCURY PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Liberty Bell 7	21 Jul 61 07:20 a.m. EST	Mercury-11 Redstone- MR-8	MR-4	ETR 5	Second U.S. suborbital manned space flight. Spacecraft, manned by astronaut Virgil I. Grissom, made successful 15 minute, 118 mile high, and 303 mile flight down range. 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 missions 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)

MERCURY PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
ORBITAL					
Mercury	25 Apr 61 11:15 a.m. EST	Mercury-8 Atlas- 100-D	MA-3	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 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)
Mercury	13 Sep 61 09:04 a.m. EST	Mercury-8A Atlas-88D	MA-4	ETR 14	Successfully completed one orbit. Capsule was recovered. Checked Mercury world-wide tracking network. (S)
Mercury	1 Nov 61 10:32 a.m. EST	Mercury-NA Scout	MS-1	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)
Mercury	29 Nov 61 10:08 a.m. EST	Mercury-9 Atlas-93D	MA-5	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)

MERCURY PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Friendship 7	20 Feb 62 09:47 a.m. EST	Mercury-13 Atlas-109D	MA-6	ETR 14	First U.S. orbital manned space flight. Mercury spacecraft, manned by John H. Glenn, Jr., completed three orbits in 81,000 mile flight lasting 4 hours, 56 minutes. Splash down in Atlantic Ocean 166 miles 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)
Aurora 7	24 May 62 07:45 a.m. EST	Mercury-18 Atlas-107D	MA-7	ETR 14	Second U.S. orbital manned space flight with M. Scott Carpenter as pilot, was placed into orbit at 17,532 miles per hour. 81,200 mile flight featured attitude stabilization and control pilotage for completion of three orbits. Re-entry error caused landing 200 miles beyond intended area; astronaut egressed through top of capsule to await rescue three hours later. (S)

MERCURY PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Sigma 7	3 Oct 62 07:15 a.m. EST	Mercury-16 Atlas-113D	MA-8	ETR 14	Walter M. Schirra, Jr., traveled 160,000 miles 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)
Faith 7	15 May 63 08:04 a.m. EST	Mercury-20 Atlas-130D	MA-9	ETR 14	Astronaut L. Gordon Cooper, manning Mercury spacecraft, completed 22 orbits, traveling approximately 593,885 miles in 34 hours, 20 minutes. Astronaut and spacecraft recovered only 36 minutes after spash down in Pacific Ocean. (S)

GEMINI PROGRAM

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
GEMINI					
Gemini I	8 Apr 64 11:00 a.m. EST	Gemini-1 Titan II GLV-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 204 mile apogee, 99.6 mile perigee and 89.27 minute period. No separation between the 7,000 pound spacecraft and the spent rocket casing was planned; orbiting assembly re-entered the atmosphere and dis-integrated about 3-1/2 days later. Test objectives achieved. (S)
Gemini II	19 Jan 65 09:04 a.m. EST	Gemini-2 Titan II GLV-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 down range Atlantic. (S)
Gemini III	23 Mar 65 09:24 a.m. EST	Gemini-3 Titan II GLV-3	GT-3	ETR 19	First manned Gemini. Virgil 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 PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Gemini IV	3 Jun 65 10:16 a.m. EST	Gemini-4 Titan II GLV-4	GT-4	ETR 19	James McDivitt, command pilot, Edward White, pilot. 62 orbits, a total of 97 hours and 59 minutes in space. First extravehicular activities (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 not achieved due to excess fuel consumption. First mission controlled from MSC. Recovery by USS Wasp. (S)
Gemini V	21 Aug 65 09:00 a.m. EST	Gemini-5 Titan II GLV-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 VI (Target Vehicle)	25 Oct 65 10:00 a.m. EST	Atlas SLV-5301 Agena 5002	GATV	ETR 14	Agena stage target vehicle for Gemini VI rendezvous disintegrated at time of ignition of main Agena engine; did not orbit. Caused postponement of Gemini VI, which was later rescheduled to rendezvous with Gemini VII. (U)

GEMINI PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Gemini VII	4 Dec 65 02:30 p.m. EST	Gemini-7 Titan II GLV-7	GT-7	ETR 19	Frank Borman, command pilot, and James Lovell, 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 one foot. Landed on December 18th, 17 miles from the USS Wasp. (S)
Gemini VI-A	15 Dec 65 08:37 a.m. EST	Gemini-6 Titan II GLV-6	GT-6	ETR 19	Walter Schirra, command pilot, Thomas Stafford, pilot. Conducted world's first rendezvous, using Gemini VII, for 5 hours, 19 minutes, approaching as near as one foot; re-entered December 16th after 25 hours, 51 minutes. Landed within 12 miles of the USS Wasp. (S)
Gemini VIII Target Vehicle	16 Mar 66 10:00 a.m. EST	Atlas-5302 Agena-5003	GATV	ETR 14	Target vehicle available for passive rendezvous. Used as a rendezvous vehicle for Gemini VIII. Re-entered atmosphere September 15, 1967. (P)

GEMINI PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Gemini VIII	16 Mar 66 11:41 a.m. EST	Gemini-8 Titan II GLV-8	GT-8	ETR 19	Neil Armstrong, Command Pilot, and David 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. EVA for one orbit not achieved. (P)
Gemini IX Target Vehicle	17 May 66 10:15 a.m. EST	Atlas-5303 Agena-5004	GATV	ETR 14	Target vehicle for GT-9. The number two Atlas engine malfunctioned, the number one engine was unable to compensate for the pitch down attitude and the missile fell into the Atlantic. (U)

GEMINI PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Gemini IX Augmented Target Docking Adapter Vehicle	1 Jun 66 10:00 a.m. 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 June 11, 1966. (P)
Gemini IX-A	3 June 66 08:40 a.m. EST	Gemini-9A Titan II GLV-9	GT-9	ETR 19	Thomas Stafford, command pilot, and Eugene 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. Splash down on June 6th, 600 miles from Cape Kennedy, 31 miles from the USS Wasp. (P)
Gemini X Target Vehicle	18 Jul 66 03:40 p.m. EST	Atlas-5305 Agena-5005	GATV	ETR 14	Rendezvous vehicle for GT-10. Launched 100 minutes before launch of GT-10. Placed in near circular orbit of 184 miles. Re-entered atmosphere December 29, 1966. (S)

GEMINI PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Gemini X	18 Jul 66 03:40 p.m. EST	Gemini-10 Titan II GLV-10	GT-10	ETR 19	John 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 476 miles, 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 July 21 after 43 revolutions. (S)
Gemini XII Target Vehicle	12 Sep 66 08:05 a.m. EST	Atlas-5306 Agena-5006	GATV	ETR 14	Launched 97 minutes before GT-11. Near circular orbit of 185 miles. Docking vehicle for GT-11. Re-entered atmosphere December 30, 1966. (S)

GEMINI PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Gemini XI	12 Sep 66 09:42 a.m. EST	Gemini-11 Titan II GLV-11	GT-11	ETR 19	Charles Conrad, command pilot, Richard Gordon, 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 851 miles. Gordon took 2 hour, 8 minute standup EVA, conducting photographic experiments. GATV and GT-11 tethered by rope. Re-entry on September 15 after 71 hours, 17 minutes, 44 revolutions. Landed 2 miles from target, picked up by USS Guam. (S)
Gemini XII Target Vehicle	11 Nov 66 02:08 p.m. EST	Atlas-5307 Agena-5001	GATV	ETR 14	Target vehicle launched 98 minutes before GT-12. Went into a 158-169 mile orbit. Trouble with propulsion system caused cancellation of plans to raise spacecraft (mated) apogee to 530 miles. Re-entered atmosphere December 23, 1966. (S)

GEMINI PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Gemini XII	11 Nov 66 03:47 p.m. EST	Gemini-12 Titan II GLV-12	GT-12	ETR 19	Manned orbital flight, with James Lovell as command pilot and Edward Aldrin as pilot. Rendezvous and docking with GATV completed on third revolution. Photos taken of total solar eclipse on November 12. Two stand-up EVA's 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 3 miles off target, picked up by USS Wasp in the Atlantic. Last Gemini flight. (S)

APOLLO PROGRAM

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
MSFN TRAINING SATELLITES					
TTS-1	13 Dec 67 09:08 a.m. EST	Delta DSV-3E (Delta-55)	TTS-1	ETR 17B	Launched as a piggy-back payload attached to rear of second stage of Delta vehicle that successfully injected Pioneer VIII into solar orbit. Timer aboard Delta second stage ejected TTS one minute after third stage ignition. Forty-pound, eight-sided (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 (MSFN) station ample opportunities to checkout equipment and train personnel. 300 statute mile apogee; 182 statute mile perigee; 33 degree inclination; 92 minute period. Re-entered atmosphere April 28, 1968. (S)

APOLLO PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
TETR-2	8 Nov 68 04:46 a.m. EST	Delta DSV-3E (Delta-60)	TETR- B	ETR 17B	The second of three training satellites launched to test the Manned Spaceflight 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 40-pound spacecraft provided an economical and dynamic medium for exercising the unified S-band systems of the MSFN. Still in orbit (apogee 530 sm, perigee 227 sm, inclination 33 degrees, 97 minute period). (S)
TETR	27 Aug 69 05:59 p.m. EST	Delta DSV-3L (Delta-73)	TETR- C	ETR 17A	This was the third and final 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)

APOLLO PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
TETR D	29 Sept 71 05:45 a.m. 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 pre-mission 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. (S)

APOLLO PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
SUBORBITAL					
Apollo-Saturn	26 Feb 66 11:12 a.m. 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 sub-orbital flight to qualify launch vehicle, space-craft command module (CM) heat-shielding and service module (SM) systems. Liftoff was nor-mal and powered flight was as programmed. After separation from the launch vehicle, spacecraft reached 310 mile 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 27,500 feet per second, reaching a re-entry heat of about 4000°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 April 24, 1967, Dr. George E. Mueller, Associate Administrator for Manned Space Flight, NASA, officially designated the test in which 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 PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo-Saturn	25 Aug 66 01:16 p.m. 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) heatshielding; first use of spacecraft fuel cell power system. Liftoff was normal. Launch vehicle developed 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 706 mile 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 19,900 mph. Maximum re-entry temperature of CM's outer surface was calculated to be about 2700° F; interior temperature was 70°F. CM landed in Pacific 500 miles 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 June 9, 1966.
On January 15, 1968, the name was changed back to Saturn IB.

APOLLO PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
EARTH ORBITAL					
Saturn	28 May 64 12:07 p.m. EST	Saturn I (SA-6)	SA-6 BP-13	ETR 37B	First major flight test in Project Apollo, with successful orbiting of first boiler-plate 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 June 1, 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 11:22 a.m. EST	Saturn I (SA-7)	SA-7 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 September 22, 1964. (S)

APOLLO PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Pegasus I	16 Feb 65 09:37 a.m. 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, 2,000 sq. ft. Still in orbit. (S)
Pegasus II	25 May 65 02:35 a.m. 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. Still in orbit. (S)
Pegasus III	30 Jul 65 08:00 a.m. 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 January 27, 1967, at 6:31 p.m. 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 death of astronauts Virgil I. (Gus) Grissom, Edward H. White II, and Roger B. Chaffee.

APOLLO PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 4	9 Nov 67 07:00 a.m. EST	Saturn V (AS-501)	AS-501 CSM-017	KSC 39A	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 115 statute mile 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 10,696 statute miles. 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 11,232 statute mile 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 10 statute miles 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)

APOLLO PROGRAM

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 5	22 Jan 68 05:48 p.m. 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 January 23, LM ascent stage re-entered on January 24, and descent stage re-entered on February 12, 1968. No attempts at recovery were planned, or made. (S)

APOLLO PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 6	4 Apr 68 07:00 a.m. EST	Saturn V (AS-502)	AS-502/ CSM-020	KSC 39A	This flight was planned as a mission similar to Apollo 4 (November 9, 1967), but in-flight problems prevented achievement of primary mission objectives. Liftoff was normal and on schedule. However, severe up-and-down vibrations of the entire space vehicle (POGO) 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 12,000 miles. This utilized most of the propellants and resulted in a Command Module (CM) re-entry of 4,000 feet per second less than planned. CM was recovered in Pacific near Hawaii, about 200 nm from the target area, 9 hours, 58 minutes after liftoff. (U)

APOLLO PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 7	11 Oct 68 11:03 a.m. 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 restarted, placing the attached spacecraft into a higher orbit. Later the CSM was separated and performed rendezvous and station-keeping maneuvers, approaching within 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 several 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 seven miles from the target point at 07:11 a.m. EDT on October 22, after a flight of 260 hours, 9 minutes (10.8 days). Seven televisions 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 after effects. (S)

Apollo 7 Astronauts

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

Apollo 7 Weights

Weight in earth orbit (S-IVB stage, Instrument Unit, Spacecraft Lunar Module Adapter (SLA), and CSM - 66,850 pounds.

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; extensive checkout of CSM systems performed during mission; 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 11:00 a.m. EST	Saturn V (AS-504)	AS-504 CSM-104 LM-3	KSC 39A	After a three-day delay due to a minor virus 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 maneuvered 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 reentry. The USS Guadalacanal had the crew aboard one hour after splashdown on March 13, completing a flight of 241 hours 1 minute (10 days, 1 hour, 1 minute). LM descent stage reentered March 22; 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 - 6,379,335 pounds
Weight in earth orbit (S-IVB stage, IU, CSM and LM) - 289,970 pounds

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.

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
LUNAR ORBITAL					
Apollo 8	21 Dec 68 07:41 a.m. EST	Saturn V (AS-503)	AS-503 CSM-103 LTA-B	KSC 39A	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 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 71 miles and a speed of about 5,720 mph, and at 04:59 Dec. 24, 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 01:10 Dec. 25, 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 6,035 mph, and only one midcourse correction was needed. At about 10,357 miles from Earth the command and service modules separated, and fifteen minutes later the command module re-entered Earth's atmosphere at a speed of 24,243 mph. On Dec. 27, Apollo 8 landed in the Pacific 5,000 yards from the recovery ship USS Essex, after a flight of 147 hours. (S)

Apollo 8 Astronauts

Frank Borman (spacecraft commander), James A. Lovell, Jr., William A. Anders

Apollo 8 Weights

Total weight - space vehicle on pad - 6,219,760 lb.
Weight in Earth orbit - spacecraft, IU, S-IVB - 282,000 lb.
Weight following translunar injection - 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 man has travelled in space to 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.

APOLLO PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
Apollo 10	18 May 69 12:49 p.m. EDT	Saturn V (AS-505)	AS-505 CSM-106 LM-4	KSC 39B	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 9.7 sm of the lunar surface. When the LM descent stage was jettisoned 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 May 26 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

T.P. Stafford, Commander; J.W. Young, CSM Pilot; E.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 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.

APOLLO PROGRAM
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	NASA Code	Site/ Pad	Remarks/Results
LUNAR LANDING					
Apollo 11	16 Jul 69 09:32 a.m. EDT	Saturn V (AS-506)	AS-506 CSM-107 LM-5	KSC 39A	Apollo 11 had the historic mission of landing a man on the moon. Liftoff and insertion into earth orbit were normal. The S-IVB stage was reignited 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 04:17:43 p.m. EDT on July 20. 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 10:55:15 p.m. 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 reentered the LM, lifted off, rendezvoused with the CSM, and returned safely to earth July 24, 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

N. A. Armstrong, Commander; Lt. Col. M. Collins, CSM Pilot; Col. E. E. Aldrin, 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 11:22 a.m. EST	Saturn V (AS-507)	AS-507 CSM-108 LM-6	KSC 39A	Apollo 12 was the second lunar landing mission. Lift-off 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 01:54:35 a.m. EST on Nov. 19, within 600 feet of the Surveyor III 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, collecting samples and parts off Surveyor III. 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 Nov. 24 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 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 III) that had been on moon 2-1/2 years; longest distance traveled on lunar surface; largest payload returned from lunar surface; and 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 02:13 p.m. EST	Saturn V (AS-508)	AS-508 CSM-109 LM-7	KSC 39A	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 April 15, 85 miles 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 substituted. 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 reentry 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 April 17, after a flight of 142 hours 54 minutes (5 days 22 hours 54 minutes). (U)

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 Spacecraft	NASA Code	Site/ Pad	Remarks/Results
Apollo 14	31 Jan 71 04:03 p.m. EST	Saturn V (AS-509) CSM-110 ("Kitty Hawk") LM-8 ("Antares") SLA-17	Lunar Landing Mission H-3	KSC LC-39 VAB HB-3 LCC-FR-2 LUT-2 PAD A ACE 2&4	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 I). 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. First 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 240m (50 000 ft) to permit a shorter, steeper LM descent path. "Antares" landed on Moon at 4:18 a.m. EST 5 Feb, 27m (87 ft) from target point in Fra Mauro highlands. During two excursions on lunar surface (totaling 9 hr, 24 min) Shepard and Mitchell covered 3.3 km (2sm), while Roosa conducted scientific experiments from CSM in lunar orbit. Lunar liftoff occurred 6 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 4:05 p.m. EST 9 Feb within 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/ Spacecraft	NASA Code	Site/ Pad	Remarks/Results
Apollo 15	26 Jul 71 9:34 a.m. EDT	Saturn V (AS-510) CSM-112 ("Endeavour") LM-10 ("Falcon") LRV-1 SLA-19	Lunar Explor- ation Mission J-1	KSC LC-39 VAB HB-3 LCC FR-1 LUT - 2 PAD A ACE 1 & 3	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 6:16 p.m. 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, sub-satellite 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 days, 7 hours, 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 IM 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 Spacecraft	NASA Code	Site/ Pad	Remarks/Results
Apollo 16	16 Apr 72 12:54 p.m. EST	Saturn V (AS-511) CSM-113 ("Casper") IM-11 ("Orion") LRV-2 SLA-20	Apollo Lunar Explor- ation Mission J-2	KSC LC-39 VAB HB-3 LCC FR-1 LUT-3 PAD A ACE 2 & 4	Mission events proceeded routinely from prelaunch countdown through CSM/LM undocking prior to IM 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 IM keep station for 5 hrs, 43 min, until a decision was made to continue the mission. "Orion" landed at 9:24 p.m. April 20 in the Descartes area, within 230 meters (755 feet) of the planned point. During three trips totalling 20 hrs, 15 min, astronauts Young and Duke covered 27.1 km (16.8 sm) over the lunar highland surface and spent 9 hrs, 7 min. on foot performing scientific duties and collecting 96.6 kg (213 lbs) 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.,2min. of stay time; rendezvous and docking were normal. Sub-satellite 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, CSM Pilot; Charles M. Duke, 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 Spacecraft	NASA Code	Site/ Pad	Remarks/Results
Apollo 17	7 Dec 72 00:33 a.m. EST	Saturn V (AS-512) CSM-113 ("America") LM-12 ("Challenger") LRV-3 SLA-21	Apollo Lunar Explor- ation Mission J-3	KSC LC-39 VAB HB-3 LCC FR-1 LUT-3 PAD A ACE 1 & 3	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 analysed and checked out on a breadboard Sequencer at MSFC and the decision was made to proceed with the countdown. The final Apollo mission lifted off 2 hrs, 40 min. late. Flight to the Moon was near routine, and "Challenger" landed at Taurus-Littrow at 2:55 p.m. EST Dec. 11. 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 Evan operated scientific equipment in the CSM "America" in lunar orbit. Lunar liftoff occurred at 5:45 p.m. EST, Dec. 14. 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 Dec. 19 the command module landed in mid Pacific 12 days, 14 hrs after liftoff, bringing to a close the Apollo manned lunar landing. (S)

Apollo 17 Astronauts

Eugene A. Cernan, Commander; Ronald E. Evans, CSM Pilot; Harrison H. Schmitt, IM 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 min, 38 sec); longest single lunar surface excursion (7 hr. 37 min, 22 sec); longest total lunar surface excursion (22 hr. 5 min, 4 sec); 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 hr 48 min -- 75 rev); longest of the Apollo missions (12 days, 14 hrs).

SKYLAB PROGRAM

Mission Name	Launch Date/Time	Launch Vehicle/ Spacecraft	NASA Code	Site/ Pad	Remarks/Results
SKYLAB 1	14 May 73 1:30 p.m. EDT	Saturn V (S-IC-513 S-11-513 OWS AM-MDA ATM Payload Shroud	SL-1	KSC LC-39 VAB HB-2 LCC-FR-2 LUT-2 PAD A	Prelaunch countdown was completed with no unscheduled holds, despite problems within the LUT 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 for the OWS. 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 and by varying the systems configuration, while t three complete purging/repressurization cycles were performed to eliminate any toxic gases emanating from materials within the OWS due to the high temperatures.

Mission Name	Launch Date/Time	Launch Vehicle/ Spacecraft	NASA Code	Site/ Pad	Remarks/Results
SKYLAB 2	25 May 73 9:00 a.m. EDT	Saturn IB (AS-206) CSM-116 SLA 23	SL-2	KSC LC-39 VAB HB-1 LCC FR-3 ML-1 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 liftoff with no unscheduled holds. Stowage of the three thermal shields and their necessary 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 slowly. On MD-3 the crew started activating the OWS. Experiments began on MD-5 and continued through MC-25. On the 14th day 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 reentered 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.

SKYLAB 2 CREW

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

Mission Name	Launch Date/Time	Launch Vehicle/ Spacecraft	NASA Code	Site/ Pad	Remarks/Results
SKYLAB 3	28 Jul 73 7:11 a.m. EDT	Saturn IB (AS-207) CSM-117 SLA-25	SL-3	KSC LC-39 VAB HB-1 LCC FR-3 LUT-1 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 24 hour seven-day-week schedule to ready SL-4 space vehicle for rescue, but decision was made to continue 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 CREW

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

KSC HISTORICAL REPORT
APPENDIX

SUMMARY OF LAUNCHINGS PRIOR TO OCTOBER 1958 BY SPACE PROJECTS LATER TRANSFERRED TO NASA

On October 1, 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, 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 September 9, 1955; the Army Ballistic Missile Agency's satellite launching project (Explorer), authorized to proceed on November 8, 1957; and certain lunar probes under the direction of the Air Force Ballistic Missile Division (forerunner of the Pioneer space probes), officially announced on March 27, 1958.

This Appendix lists the launching attempts in these programs that occurred prior to October 1, 1958. Launching attempts made subsequent to October 1, 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 LAUNCHINGS PRIOR TO OCTOBER 1958 BY SPACE PROJECTS LATER TRANSFERRED TO NASA
(All launchings were from Cape Canaveral)

Mission Name	Launch Date/Time	Launch Vehicle	Intntl. Desig.	Site/ Pad	Remarks/Results
EXPLORER					
Explorer I	31 Jan 58 10:07 p.m. EST	Juno I (Jupiter C) RTV-4	1958 Apha	26A	Explorer I, the first American satellite, was successfully launched into an orbit with an apogee of 1,573 miles and a perigee of 224 miles. The satellite, 80 inches long and 6 inches in diameter, was an integral part of the launch vehicle's fourth stage motor case, and weighed 30.8 pounds. Its payload, weighing 18.13 pounds (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 I resulted in the discovery of belts of radiation surrounding the Earth (the Van Allen belts). The satellite transmitted data until May 23, 1958, and re-entered Earth's atmosphere March 31, 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 I's constructed, three successfully orbited satellites.) (S)

SUMMARY OF LAUNCHINGS PRIOR TO OCTOBER 1958 BY SPACE PROJECTS LATER TRANSFERRED TO NASA
(All launchings were from Cape Canaveral)
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	Intntl. Desig.	Site/ Pad	Remarks/Results
Explorer II	5 Mar 58 01:27 p.m. EST	Juno I (Jupiter C) RTV-5	--	26A	An attempt to orbit the Explorer II 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, 1,900 miles from the launching site. (U)
Explorer III	26 Mar 58 12:30 p.m. EST	Juno I (Jupiter C) RTV-6	1958 Gamma	5	Explorer III, the third U.S. IGY satellite, was successfully launched into an orbit with an apogee of 1,746 miles and a perigee of 121 miles. The satellite instrumentation was similar to that of Explorer I, with the addition of a tape recorder feature. On May 1, 1958, Dr. James A. Van Allen announced that scientific findings from Explorers I and III disclosed an unexpected band of high-intensity radiation extending from 600 miles above Earth to possibly an 8,000 mile altitude. The Explorers also showed that the atmosphere at 220 miles 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 III transmitted data until June 16, 1958 and reentered the atmosphere June 28, 1958. (S)

SUMMARY OF LAUNCHINGS PRIOR TO OCTOBER 1958 BY SPACE PROJECTS LATER TRANSFERRED TO NASA
(All launchings were from Cape Canaveral)
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	Intntl. Desig.	Site/ Pad	Remarks/Results
Explorer IV	26 Jul 58 10:00 a.m. EST	Juno 1 (Jupiter C) RTV-7	1958 Epsilon	5	The fourth U.S. IGY satellite was successfully launched by a Juno 1into an orbit with an apogee of 1,380 miles and a perigee of 163 miles. 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 IV transmitted data until October 6, 1958 and re-entered the atmosphere on October 23, 1959. (S)
Explorer V	24 Aug 58 00:17 a.m. EST	Juno 1 (Jupiter C) RTV-8	--	5	The fifth orbital attempt by the Army Ballistic Missile Agency, using the Juno 1 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 LAUNCHINGS PRIOR TO OCTOBER 1958 BY SPACE PROJECTS LATER TRANSFERRED TO NASA

(All launchings were from Cape Canaveral)
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	Intntl. Desig.	Site/ Pad	Remarks/Results
VANGUARD					
Vanguard Test Vehicle	6 Dec 57 11:45 a.m. 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 six inches off the pad. (Previous Vanguard project launchings at Cape Canaveral were launch vehicle development tests, not orbital attempts.) (U)
Vanguard Test Vehicle (Backup)	5 Feb 58 02:33 a.m. 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 60 seconds after launching, 4 miles up. The rocket was destroyed by the range safety officer. (U)

SUMMARY OF LAUNCHINGS PRIOR TO OCTOBER 1958 BY SPACE PROJECTS LATER TRANSFERRED TO NASA
(All launchings were from Cape Canaveral)
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	Intntl. Desig.	Site/ Pad	Remarks/Results
Vanguard I	17 Mar 58 07:25 a.m. EST	Vanguard TV-4	1958 Beta 1 (Casing) 1958 Beta 2 (Satellite)	18A	Vanguard I, the second U.S. Satellite, an aluminum test sphere 6.4 inches in diameter and weighing 3.25 pounds, was successfully launched into orbit, together with its 50-pound 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 409 miles, and apogee was 2453 miles, at an inclination to the equator of 34.26 degrees. 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. (S)
Vanguard Test Vehicle	28 Apr 58 09:50 p.m. EST	Vanguard TV-5	--	18A	Attempt to orbit an instrumented satellite 20 inches in diameter and weighing 21.5-pounds, 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 1,500 miles down range. (U)

SUMMARY OF LAUNCHINGS PRIOR TO OCTOBER 1958 BY SPACE PROJECTS LATER TRANSFERRED TO NASA
(All launchings 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 10:46 p.m. 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 measurers, and thermometers. Liftoff was normal, and all vehicle stages fired. However, improper burnout of second stage resulted in too steep a climb angle and failure to achieve orbit. Reached an altitude of 2,440 miles and burned up on re-entry between Antigua and Africa, 5,000 miles away. Satellite radio returned some data. (U)
Vanguard Satellite Launch Vehicle	26 Jun 58 00:01 a.m. EST	Vanguard SLV-2	--	18A	Second orbital attempt using a production Vanguard launch vehicle. Satellite instrumentation was the same as for April 28 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 LAUNCHINGS PRIOR TO OCTOBER 1958 BY SPACE PROJECTS LATER TRANSFERRED TO NASA
(All launchings 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 10:38 a.m. EST	Vanguard SLV-3	--	18A	Following an abortive attempt on September 17, in which the vehicle lifted about 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, Vanguard SLV-3 was launched on this date. Liftoff was normal, and all stages 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 of 265 miles before falling into the Indian Ocean, approximately 9,200 miles 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 LAUNCHINGS PRIOR TO OCTOBER 1958 BY SPACE PROJECTS LATER TRANSFERRED TO NASA

(All launchings were from Cape Canaveral)
(continued)

Mission Name	Launch Date/Time	Launch Vehicle	Intntl. Desig.	Site/ Pad	Remarks/Results
PIONEER					
Pioneer	17 Aug 58 07:18 a.m. 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 10 miles. The mission had been designed to put 40 pounds 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 meteorite counter, and thermometers. Had the mission been successful, the probe would have been given the designation of Pioneer. (U)